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RIGHT-SHORING: OFFSHORING TO RESHORING FOR A SUSTAINABLE MANUFACTURING LOCATION DECISION IN THE HEALTHCARE INDUSTRY

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RIGHT-SHORING: OFFSHORING TO RESHORING FOR A SUSTAINABLE MANUFACTURING LOCATION DECISION IN THE HEALTHCARE INDUSTRY

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ABSTRACT

Firms have increasingly offshored manufacturing to foreign countries in the past decades due to the expected benefits driven by low manufacturing costs in developing economies. With changes in competition and government pressure for domestic production, however, manufacturing firms have reevaluated these decisions leading some to reshore manufacturing activities. Recent studies have investigated various reshoring motivations and developed conceptual frameworks that can be used as tools in reshoring decisions. However, the complexity in decision making remains high due to product and industry specific traits impacting the manufacturing process. Examples include the increasing concern over product quality and changing regulations. Two industries that are heavily impacted by reshoring decisions are medical device and pharmaceutical companies. Theoretical support for these decisions have been limited with most studies relying on Transaction Cost Economics (TCE) and Resource Based Review (RBV). While valuable, these theories are insufficient to explain the growing number of decision variables involved in reshoring. This study proposes that Dunning's ownership, location, and internalization (OLI) framework explains more of the recent decision variables related to reshoring. Based on four sub-paradigms of the OLI framework, this study develops a reshoring decision model using a systematic literature review (SLR) and semi-structured interviews. Then, the study tests the model using a large-scale survey. Results show that reshoring decisions in the medical device and pharmaceutical industries are dominated by quality and regulatory requirements that involve long and complex validation processes, among others. Lastly, using authentic industry parameters in an analytical model, this study

demonstrates the impact of reshoring and offshoring cost factors on reshoring decisions. Managerial and theoretical implications are discussed.

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DEDICATION

I dedicate my dissertation to my family who have provided me with the greatest support and love in the world throughout this long journey. My parents, Seokchong and Mikyeong, and my sister, Yeojin, have always sacrificed for me and consistently shown their faith in me. I am also thankful for my two cats, Namu and Charlie, whose existence itself has brought joy to me during difficult times.

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INTRODUCTION

Research background

Defined as "moving manufacturing back to the country of its parent company" (Ellram, 2013, p.3), reshoring decisions are gaining interest in recent years as a strategic economic activity for businesses with corresponding societal benefits. In that sense, reshoring can be viewed as an activity that supports organizational sustainability according to the triple bottom line (TBL) framework by Elkington (1994), which includes economic, social, and environmental sustainability. Yun et al. (2019) find that current studies on the interaction between economic and social performance have a narrow focus on charitable corporate social responsibility (CSR) activities because of the difficulty in developing measures for social performance. The limited scope of social performance relies on the benevolence of corporations, for example, ranging from cash donations to assignments of company resources to charities. It often does not associate CSR with an outlay of resources contributing to economic performance at the firm level. However, corporate consideration of reshoring can be understood as an important strategic decision that improves an organization's economic sustainability that leads to business continuity as well as social sustainability. Thus, a company's reshoring decision to increase profitability can also improve social performance by supporting local suppliers, for example, (Ashby, 2016) and thus by creating employment opportunities in society.

Job creation and tax benefits are considered positive impacts of reshoring by improving the lives of stakeholders in home countries that support domestic production. This may be particularly true for manufacturing companies in the

healthcare industry which provide products that have a critical impact on human well-being and revenue generation. These firms have increasingly outsourced manufacturing to foreign countries due to the expected benefits driven by low costs in developing economies. However, with changes in the internal and external environment and government pressure for domestic production, some manufacturing firms have reevaluated their offshoring decisions and reshored manufacturing. Recent studies have investigated various reshoring motivations and have developed conceptual frameworks that can be used as tools in reshoring decisions. However, these tools are limited due to the increasing complexity in decision making driven by product and industry specific traits. In healthcare, pharmaceutical and medical device companies are hugely impacted, especially around product quality and changing regulations.

When a firm considers reshoring, there are three possible outcomes:

1) Full reshoring: where a firm moves all production back to a home country;
2) Partial reshoring: where a firm moves only partial production back to a home country while keeping the remainder in the foreign location(s); and
3) No Reshoring: where a firm keeps all production in a foreign location(s).

Given rational economic models, a firm will select the option that provides the greatest benefit. The outcome that achieves the best performance is referred to as "right-shoring" (Tate and Bals, 2017; Joubioux and Vanpoucke, 2016). Right-shoring involves a review of a company's "shoring" options for repositioning manufacturing to meet firm objectives (Tate and Bals, 2017). This process involves a consideration of the original offshoring motivation as well as reshoring drivers that may differ from the

original offshoring decision. This decision requires a deeper understanding of both qualitative and quantitative variables in the decision process. Thus, this study attempts to investigate the factors that are considered in reshoring decisions and how these factors can lead to right-shoring. A better understanding of these decision making factors will improve organizational sustainability based on the social and economic contribution of companies.

Research questions

The purpose of the study is to examine factors that impact manufacturing reshoring decisions in the context of the healthcare industry and investigate how reshoring can contribute to a right-shoring decision. This study achieves this goal by answering the following research questions:

- What factors impact manufacturing reshoring decisions in the healthcare industry?
- How do these factors impact reshoring decisions of medical device and pharmaceutical companies?
- What is an optimal right-shoring solution?

By answering these questions, this study makes contributions to the literature in four areas. First, it is the first study to develop and empirically test a decision model for reshoring in the context of medical devices and pharmaceuticals. The extant literature suggests that variables impacting reshoring decisions vary from firm to firm, product to product, and thus firm and product specific approaches are needed to understand reshoring factors. Second, this study treats reshoring as an investment

decision based on Dunning's ownership, location, and internalization (OLI) investment framework (Dunning, 1980). The study empirically examines why companies consider reshoring decisions that can differ from their original offshoring decisions. This provides a theoretical lens to see reshoring as a strategic location and sourcing decision without treating reshoring simply as a temporary condition driven by short-term cost benefits or immediate political and economic stability. Third, this study also suggests that reshoring results in a positive interaction between economic and social variables that improve sustainability without reliance on CSR or charitable activities. Fourth, based on the results of the interviews and survey, a rudimentary analytical model demonstrates how right-shoring can lead to optimal solutions for reshoring manufacturing in healthcare. This model is a practical tool that uses transportation cost as a differentiator that impacts reshoring decisions by examining the balance between offshoring and reshoring. It shows that an optimal balance may exist to inform right-shoring decisions.

Multi-method approach

To answer the research questions, this study uses multiple methods including:

1) Systematic literature review (SLR)
2) Semi-structured interviews
3) Large-scale survey
4) Rudimentary analytical model

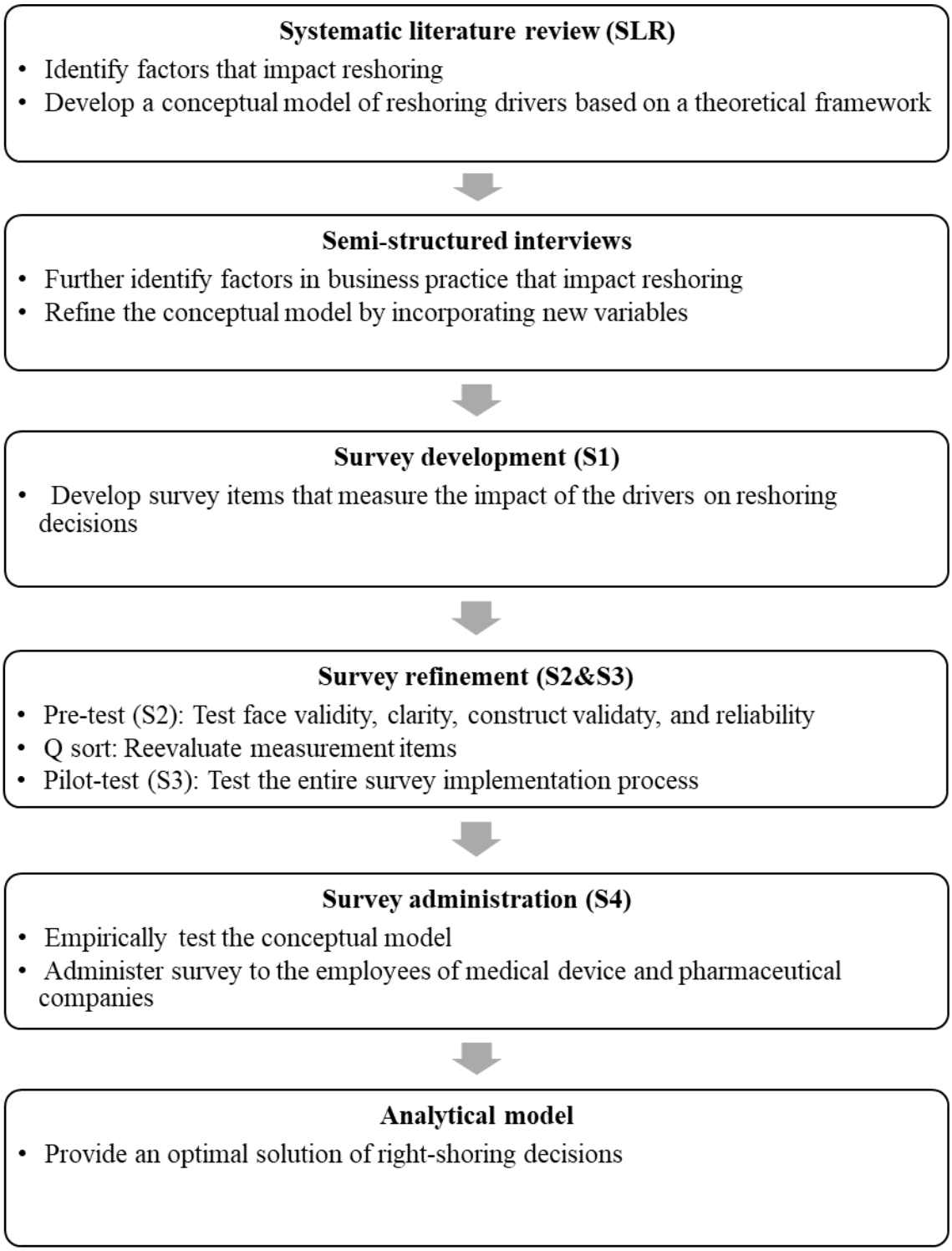
An overview of how these methods are used is described sequentially in Figure 1 followed by a detailed explanation of the procedure.

First, a systematic literature review (SLR) is conducted to identify current research gaps and the existing variables that are used in reshoring decisions. The identified variables are categorized based on a theoretical framework and developed into a conceptual model. Since the topic of reshoring is still exploratory, a series of semi-structured interviews is conducted with practitioners in the medical device and pharmaceutical industry to identify new variables relevant to this research. The interviews are continued until *theoretical saturation* is reached (Robinson, 2014). *Theoretical saturation* is the point where no new information is being discovered through data collection, in this case interviews (Suddaby, 2006). The topic is theoretically saturated with knowledge. It is "theoretical" because it is practically impossible to demonstrate that all knowledge is captured through any methodology. The variables found in the interview process are incorporated into the conceptual model and some parameters are eventually used in an analytical model.

To empirically test the conceptual model of reshoring factors, a large-scale survey is employed using Dillman's (2009) approach. This procedure contains four steps: Step 1 (S1) - survey development, Step 2 (S2) - pre-test, Step 3 (S3) - pilot-test, and Step 4 (S4) - administration (see Figure 1). A questionnaire is developed based on the literature and the conceptual model. The initial questionnaire includes questions on demographic information and 65 items from the conceptual model. Four questions on product complexity, product standardization, technology intensity, and labor intensity are added to measure product characteristics.

Then, the survey is pre-tested for readability, face validity, and content validity on a group of academics and MBA students (Pre-test 1).

Figure 1. Description of methodological procedure



Many revisions are recommended to an extent where a second pre-test is warranted (Pre-test 2). After the revisions are made, the second pre-test is conducted on a group of 14 mid-level managers and scientists in the medical device and pharmaceutical industries. As recommended by Dillman (2009; 2014), the second pre-test is conducted in the presence of the researcher so that body language can be observed and the respondents can ask questions and provide oral feedback. To facilitate this, Pre-test 2 includes a group debriefing assessment which identifies major issues demanding a reevaluation of the measurement items and topic clarification (Ruel et al., 2016). The participants reported that,

1) while the variables and factors reflect their experience, some of the conceptual associations between the variables and factors are incorrect;

2) the survey is too long at 65 questions, driven by too many redundant items measuring variables that can be measured by single items; and

3) the questions are too wordy and description of variables can be simplified because the instrument will be delivered to professionals in the field.

To correct associations between the variables and factors, a multi-round Q-sort is conducted with the Pre-test 2 group using a Delphi approach (McKnight, 2008; Brady, 2015), which is recommended as a method to assess reliability and construct validity at the pre-testing stage (Nahm et al., 2002). A Delphi systematically allows participants to see and hear the responses of others when classifying variables and their relationships. As a result, the group reclassified the 65 indicators into 15 different categories, and items with unnecessary redundancy were reevaluated and excluded, resulting in a reduction of the instrument to 54 indicators (items); 15 categories were

the higher order grouping variables while the 54 were individual reshoring drivers. This reclassification allowed for refutability of the variables that do not conceptually associate with the theoretical framework. A second round of Delphi sought consensus on classification. The 19 indicators that did not achieve over 75% of agreement (McKnight, 2008) in the process were dropped. After another round of revisions based on the dropped items, a new survey instrument containing 35 items was tested again on the same Pre-test 2 group. No further revisions were recommended.

To minimize potential sampling bias due to the convenience sample for Pre-test 2, a pilot-test is then performed on the new 35-item instrument with a new group of 16 respondents from the medical device industry and 14 respondents from the pharmaceutical industry. Unlike the Pre-test 2 group who work for a company that manufactures both pharmaceutical and medical devices that used complimentary technologies, the pilot-test group work for companies that only manufacture one or the other. The results of the pilot-test lead to a minor revision to the introductory statements and no changes to the 35 items. Due to only minor revisions to the instrument, a second pilot-test is deemed unnecessary.

The final survey is administered online to mid-to-upper level managers and technical personnel in medical device and pharmaceutical manufacturing firms in the U.S. Since there are no substantial revisions to the instrument resulting from the pilot-test group, the pilot-test responses are retained as part of the full sample. The first 30 responses from the final survey sample are compared with the pilot-test responses. A simple correlation was used to compare the two samples. The correlation between the two groups is significant at $r = .60$, suggesting that methods bias is not affecting the

responses. It is important to note that approximately 50% of usable responses are collected directly by the researcher while 50% of usable responses are collected through a research firm that charge a fee for their services.

Lastly, a rudimentary analytical model is developed based on real-world parameters collected during the interviews. The model demonstrates how to quantitatively optimize a right-shoring decision when faced with both domestic and foreign production options. The model uses parameters from a real medical device company based on assumptions that are context specific.

The rest of this study is organized as follows. Section 2 presents the methodology and the result of the systematic literature review, which is followed by semi-structured interviews in Section 3. The measurement model is tested using a survey and the results are discussed in Section 4. In Section 5, an analytical model for right-shoring is proposed. Conclusion, limitations, and future direction of this dissertation are discussed in Sections 6 and 7. As a result, this study suggests how reshoring can be used as a strategic “right-shoring” decision for medical device and pharmaceutical companies.

LITERATURE REVIEW

Defining right-shoring

Studies (Hilletofth et al., 2019; Tate and Bals, 2017; Joubioux and Vanpoucke, 2016) use the term "right-shoring" in relation to recently increasing reshoring activities used in strategic location decisions that originated from offshoring. Likewise, the term "right-shoring" in this research refers to location decisions based on estimating the balance of domestic versus foreign (offshored) production to achieve corporate objectives. While the first part of the study focuses on reshoring as the reverse strategic decision to offshoring, the later part of the study demonstrates, based on this understanding, how reshoring can be considered a right-shoring decision using an analytical model.

Theoretical background

As a theory in international business, the ownership, location, and internalization (OLI) framework, also known as the eclectic paradigm, was initially developed by Dunning (1973) to explain foreign direct investment (FDI) and foreign activities of multinational enterprises (MNEs). Dunning (1973) developed the theory to explain why firms invest overseas and what determines the amount and composition of international production. The OLI framework explains that three determinants are considered in internationalization impacting propensity to engage in foreign production: ownership advantages, location advantages, and internalization advantages. Ownership advantage is the possession of a certain valuable, rare, hard-to-imitate, and an organizationally embedded resource that allows a company to have a competitive

advantage. Location advantage is the advantage associated with particular locations that are separate from ownership advantages which may or may not be transferable from the locations or can be combined with products in a home country. Internalization advantage is an advantage gained through direct ownership of production in another country rather than producing through a partnership arrangement in the foreign country, such as licensing, contract manufacturing, or a joint venture. In the presence of all three of these advantages, firms are likely to invest in foreign production options such as offshoring.

Extending the theory to include observable factors, Dunning (1998; 2000) developed four sub-paradigms of these advantages. They are:

1) Resource seeking (RS): to gain access to natural resources, such as agricultural products, unskilled or skilled labor, unique technology; supply oriented;
2) Market seeking (MS): to satisfy growing or existing demand in a particular foreign market(s);
3) Efficiency seeking (ES): to promote a more efficient division of labor or specialization of an existing portfolio of foreign and domestic assets; related to RS and MS; and
4) Strategic asset seeking (SAS): to protect or augment the existing ownership specific advantages of the investing firms or to reduce those of the competitors.

Studies by Ellram et al. (2013) and Ancarani et al. (2015) use these sub-paradigms of the OLI framework to conceptually categorize reshoring drivers discovered to that point. These studies explain that reshoring occurs as a consequence of the changes in the advantages in the OLI framework (Ellram, 2013; Johansson and Olhager, 2018)

since reshoring requires consideration of internationalization factors (Presley et al., 2016). Thus, firms decide to withdraw due to the relative decrease in ownership, location, and internalization advantages and the four sub-paradigms that explain specific motivations. Ancarani et al. (2015) find an association between the duration of offshored firms and reshoring motivations, such as technology, customization, decrease in cost differentials, physical distance, organization archetypes, firm size, and "made-in" effect. In the same vein, looking at reshoring as a fundamentally strategic location decision, this study uses the four sub-paradigms of location advantage as the theoretical framework to conceptualize and empirically test a reshoring model.

Systematic literature review (SLR)

A systematic literature review (SLR) (Tranfield et al., 2003; Durach et al., 2017) is used as a structured approach to identify a gap in the reshoring literature and identify reshoring drivers in the extant literature. The review process follows three major stages promoted by Tranfield et al. (2003), and six detailed steps suggested by Durach et al. (2017). The three stages include Stage I planning the review, Stage II conducting the review, and Stage III reporting and dissemination of the results.

Stage I – Review protocol

In Stage I, a review protocol is developed based on the research questions to guide how the review should be conducted in Stage II. Due to the exploratory nature of the topic, the reshoring concept is also characterized by other terms, such as back-shoring, back-reshoring, and on-shoring. Thus, search keywords such as "reshoring", "back-

shoring", "on-shoring", and "manufacturing relocation" were used for an initial search of the articles using ABI/INFORM and Google Scholar as the primary and secondary database. While ABI/INFORM identifies articles focusing on business, Google Scholar provides a wider range of scholarly resources that may be missing in the ABI search (Howland et al., 2009). Because of the small number of studies on reshoring, the initial search included all of the relevant sources, such as white papers, conference proceedings, dissertations/theses, books, and journal articles published between 2009 and 2018. Reviewing references of these sources allowed for a thorough search process. After a review, only scholarly journal articles were included in the data synthesis and analysis to improve the rigor of the study (Gunasekaran and Ngai, 2005). The review excluded articles that are merely anecdotal opinions without scientific evidence. Scholarly articles were chosen based on two major inclusion criteria:

- Articles that have a primary focus on reshoring drivers and/or motivations, or that discuss at least one reshoring motivation; and
- Articles that are published in scholarly journals.

The reviewed articles are not limited to a certain list of selected journals. They include journals in operations, supply chain management, and technology with various methodological emphases and topics.

As systematic coding and analysis are important in SLR, this study uses a canonical coding approach promoted by Carnevalli and Miguel (2008). Detailed coding schemes in Appendix A represent a quality evaluation of the articles based on research objectives, which includes:

1) publication year,

2) name of journal,
3) methodology,
4) research type,
5) definition of reshoring,
6) research context – country and industry,
7) how reshoring is initiated: reverse of a previous offshoring failure, strategic choice, or reaction to changes in business environment,
8) research theme,
9) unit of analysis,
10) documentation type, and
11) motivations of reshoring.

Stage II – Review

As a result of the initial search and article selection process, 52 scholarly articles in 28 different journal outlets are identified. These articles are coded based on the name of the journal in Appendix B. Data is extracted with a primary focus on reshoring drivers that are formed into a conceptual model. Evaluation of data quality is conducted based on the review protocol in Stage I. The results are further explained in the next section, Stage III.

Stage III – Report and dissemination

Fifty-two studies published from 2009 to 2018 are identified for data analysis. Most of the articles use conceptual and empirical methods, such as literature reviews, surveys, and case studies that discuss at least one reshoring motivation.

Existing studies empirically examine the motivations for reshoring decisions mainly in Europe (i.e. Germany, Finland, Sweden, and Denmark) and the U.S. Studies suggest that reshoring decisions can differ by context due to various characteristics, such as firm size, industry, product customization, and ownership mode (Benstead et al., 2017; Ancarani et al., 2015). Industry can be a particularly important factor in relocation decisions (Pennings and Sleuwaegan, 2000; Kinkel, 2012; Fratocchi et al., 2014) because of the relation to the initial motivation of offshored manufacturing activities.

As the extant literature suggests, initial offshoring activities are primarily driven by low cost advantage. Both labor-intensive and technology-intensive manufacturing are initially offshored based on resource and market seeking motivations. However, labor-intensive manufacturing is focused on low labor costs while technology-intensive manufacturing seeks to locate overseas to acquire unique technology or knowledge. In the same vein, industry is prone to specific reshoring motivations having a significant impact on "reshoring propensity" as suggested by Canham and Hamilton (2013). The product type as well as industry are important in that production requiring high levels of direct labor is likely to migrate to low cost regions, not the final market which the products serve (MacCormack et al., 1994). Furthermore, products with higher levels of customization have higher manufacturing complexity due to limited ability to control outsourced manufacturers (Hartman et al.,

2017). Offshoring strategy is still common for these products such as electronics and automotive (Ciravegna et al., 2013; Mudambi and Venzin, 2010). Offshoring these products often results in longer lead times since they require close coordination and interaction among suppliers, especially those with a high degree of customization (Ancarani et al., 2015).

Canham and Hamilton (2013) find that context has a significant impact on reshoring decisions. The context derived from current research is limited because it focuses on a certain labor-intensive industry or a "one-size-fits-all" approach versus a high-tech, high-skilled, or highly-regulated industry. The existing reshoring frameworks are developed to be used industry-wide. A few studies (Canham and Hamilton, 2013; Johansson and Olhager, 2018) examine how firm-level characteristics such as manufacturing process, export intensity, research and development (R&D) intensity, production complexity, product specialization, production volume, and labor intensity affect offshoring decisions. However, there has been no study which evaluates reshoring decision factors at the industry level, which has been shown to be important in offshoring. More specifically, this study finds no research on reshoring conducted in the context of the healthcare-related manufacturing industry that differentiates it from reshoring decisions in other industries.

Among 52 studies on reshoring published from 2009 to 2018, nine studies (Kinkel and Maloca, 2009; Kinkel, 2012; Tate et al., 2014; Fratocchi et al., 2016; Zhai et al., 2016; Delis et al., 2017; Kim et al., 2017; Heikkila et al., 2018; Johansson et al., 2018) investigate motivations for reshoring including cases in the medical, pharmaceutical, biotech, or biomedical industry sectors. None of these studies

examine how their reshoring motivations may differ from other industry sectors. Studies that examine reshoring in a standalone industry focus on metal and electrical (Kinkel, 2014; Brennan et al., 2015), shoes and apparel (Mezzadri, 2014; Martinez-Mora and Merino, 2014; Baraldi et al., 2018), and electronics and automotive (Ancarani et al., 2015). Detailed classification of the articles in the literature review is presented in Appendix B. Appendix C describes the industry sectors that are addressed in the reviewed articles based on the International Standard Industrial Classification of All Economic Activities (ISIC) code.

Appendix D summarizes the reshoring drivers identified in the literature review. In total, 122 concepts and topics are found to impact reshoring decisions based on the search criteria. Column three in Appendix D provides the references. The result show that factors in reshoring manufacturing tend to be dominated by variables such as location advantages for labor costs, lower risks, and the economic health and size of local economies (Lampel and Giachetti, 2013). Given offshoring is an antecedent for reshoring, reshoring is often understood as simply an extension of strategic offshoring decisions (Delis et al., 2017). This suggests that reshoring is viewed as the reverse of offshoring. Thus, drivers for reshoring can be barriers for offshoring, and thus challenges for reshoring can be motivations for offshoring (Wiesmann et al., 2017). In other words, reshoring can be influenced by the original motivation for offshoring. For example, the expected benefits of reshoring can be affected by performance and consumers, e.g. quality issues and “made-in” effect (Ancarani et al., 2015).

The original 122 different offshoring and reshoring drivers shown in Appendix D are evaluated for commonality and simple semantic differences. This allowed the

drivers to be categorized into 63 items using content analysis (Seuring and Gold, 2012). The content analysis is based on understanding the variables that lead to location decisions as suggested by Dunning (1998), which form the conceptual model shown in Figure 2. Reshoring drivers under efficiency seeking (ES) advantage are conceptually categorized into two factors, cost drivers and performance measures. The content analysis revealed that many described the same underlying phenomena, but used different terms or different theoretical frameworks without changing the meaning. These include both internal and external factors such as labor costs, quality, government policy, and host country risks (Kinkel and Maloca, 2009; Vanchan et al., 2018; Heikkila et al., 2018).

Reshoring is also discussed from the perspective of supply chain flexibility and resilience, which benefits supplier relationships through better integration (Bailey and De Propris, 2014). From the perspective of supply chain risk, offshoring decisions are related to product, partner, and environmental characteristics (Schoenherr et al., 2008). Studies such as Mihalache and Mihalache (2016) and Di Mauro et al. (2018) identify product cost as the most important risk factor to consider in offshoring decisions. They find that over the past decade, offshoring is dominated by ES advantages, particularly labor cost, followed by resource seeking advantages (RS), such as labor capability and process knowledge that are too costly to obtain otherwise. This has led low cost countries to engage in aggressive promotion campaigns to attract offshore manufacturing (Aspelund and Butsko, 2010). In addition to financial concerns for offshoring in developing countries, studies also find that competitive advantages, such

as product and process innovation (Lewin et al., 2009) are important ES motivations for offshoring decisions.

Although less dominant, motivations for strategic asset-seeking (SAS) and market-seeking (MS) advantages are also important including proximity to customer demand (Kinkel, 2012; Ellram et al., 2013), new product development technologies (Mohiuddin and Su, 2013), access to local markets, government and regulation incentives, quality of human capital, and access to talents (Caniato et al., 2015; Kinkel and Maloca, 2009; Vanchan et al., 2018; Heikkila et al., 2018). Roza et al. (2011) argue that firm size may create unique strategic objectives for offshoring decisions, suggesting that strategies of small firms differ from those of large corporations. For example, offshoring decisions for small and large firms may be driven by cost factors, while medium-sized firms tend to use offshoring for entrepreneurial drivers that can differentiate the firms in the competitive market by, for example, gaining access to new markets.

MacCormack et al. (1994) point out that current cost-based models for international manufacturing location decisions are not sustainable because firms experience dynamic changes in their external environment. ES advantages that are purely cost-driven can vanish quickly based on external changes. With increasing automation and enabling technologies such as 3D printing, direct labor costs are less emphasized in modern production processes. With less cost pressure, manufacturing can move to locations with more SAS advantages. These factors are based on long-term perspectives such as; 1) high-value activities, 2) availability of tangible and

intangible resources in offshored regions, and 3) recovery from offshoring failures and changing market situations.

Importance of healthcare-related manufacturing

Recent government regulation has ratcheted up the pressure on domestic production by U.S. medical device and drug manufacturers with concerns about soaring drug prices (Rockoff, 2017). As the global healthcare market is rapidly growing and expected to reach $10.059 trillion by 2022 (Deloitte, 2019), concerns deepen. Healthcare products play an important role in this sense due to their revenue generating effect on the economy and direct impact on human well-being.

Table 1. Definitions of medical device and drug (U.S. FDA, 2017; 2019)

Medical device	Pharmaceutical (Drug)
"...an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is: recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them, intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or intended to affect the structure or any function of the body of man or other animals, and which does not achieve any of its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes."	• "A substance recognized by an official pharmacopoeia or formulary. • A substance intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease. • A substance (other than food) intended to affect the structure or any function of the body. • A substance intended for use as a component of a medicine but not a device or a component, part or accessory of a device. • Biological products are included within this definition and are generally covered by the same laws and regulations, but differences exist regarding their manufacturing processes (chemical process versus biological process.)"

The two dominant product categories in this industry are medical devices and pharmaceuticals. As defined by the U.S. Food and Drug Administration (FDA) in Table 1, these products directly support healthcare services, and thus, patient care.

Medical devices and pharmaceuticals are examined in this study because of their huge impact on the economy and human life. Unlike other high-tech products such as consumer electronics, perceived risks of medical devices and drugs on human bodies are relatively high. Medical device and pharmaceutical companies operate in different sectors, and specific regulatory frameworks applied on each differ depending on the level of risks (i.e. less strict on medical devices). However, both of these two industry sectors are required to meet regulations in the product development and manufacturing process under FDA control (in the U.S.) due to direct and indirect impacts on humans. Additional quality system standards such as ISO 13485 and Good Manufacturing Practice (GMP) are demanded by customers in order to meet their high quality expectations. High levels of R&D investment are also associated with manufacturing medical devices and drugs (Marucheck et al., 2011).

In previous years, the production and associated supply chains of medical device and pharmaceutical manufacturers have increasingly globalized due to low cost and favorable regulations in overseas locations such as China (Ni et al., 2017). Rising R&D costs and the demand for low cost healthcare encourage firms to move to emerging economies to reduce costs (Mohiuddin et al., 2017). Hamdouch and He (2009) find that offshoring strategies of medical products significantly lower R&D costs through the cost differential between home country and developing regions, such as India and China. However, healthcare manufacturers experience challenges created

by their offshoring strategy – for example, product quality risk created by a loss of control (Gray et al., 2011). The outsourcing of R&D and technology intensive processes, such as pharmaceuticals, can result in a higher level of defective products. Offshoring creates longer and more complex supply chains with current manufacturing processes regulated by manufacturing guidelines to assure safety and quality (Chowdary and George, 2012).

Furthermore, quality risk that impacts safety is higher for these products because there is a lag between development, production, and customer use. The issues are often not realized until consumers are actually harmed while using the devices or drugs. A study by Huq et al. (2016) reports that quality defects remain a major concern in the pharmaceutical industry and that the low cost of suppliers may not compensate for quality risk. Moser and Montalbano (2018) assert that the number of recall notices for Chinese made consumer goods are substantially growing, showing a six times higher recall rate than U.S. made products. Thus, these industries require higher levels of regulatory restrictions and oversight by the FDA due to their medical use (Marucheck et al., 2011). These issues occur due to previous offshoring strategies. However, as Grackin (2008) argues, solely cost-based sourcing decisions are not appropriate for manufacturing these products. These industry sectors create competitive advantage through R&D rather than low skilled and low cost labor that is traditionally employed in manufacturing sectors (Silva, 2008).

The issues of the current offshoring practices raise the importance of examining reshoring in the context of healthcare manufacturing. Medical devices and pharmaceutical industries have gained increasing importance due to distinct

characteristics of high cost and heavily regulated production requirements. Reshoring is increasing among medical device manufacturers due to concerns about quality, intellectual property, etc., according to the *Reshoring Initiative*, an organization that is dedicated to encouraging reshoring back to the U.S. Despite the high stakes in medical devices and drug manufacturing, research on how these reshoring decisions are made is sparse. However, understanding reshoring in the context of the healthcare industry is critical because of increasing concerns about rising costs of healthcare in many countries that affect the sustainability of businesses and social benefits.

Summary of the literature review

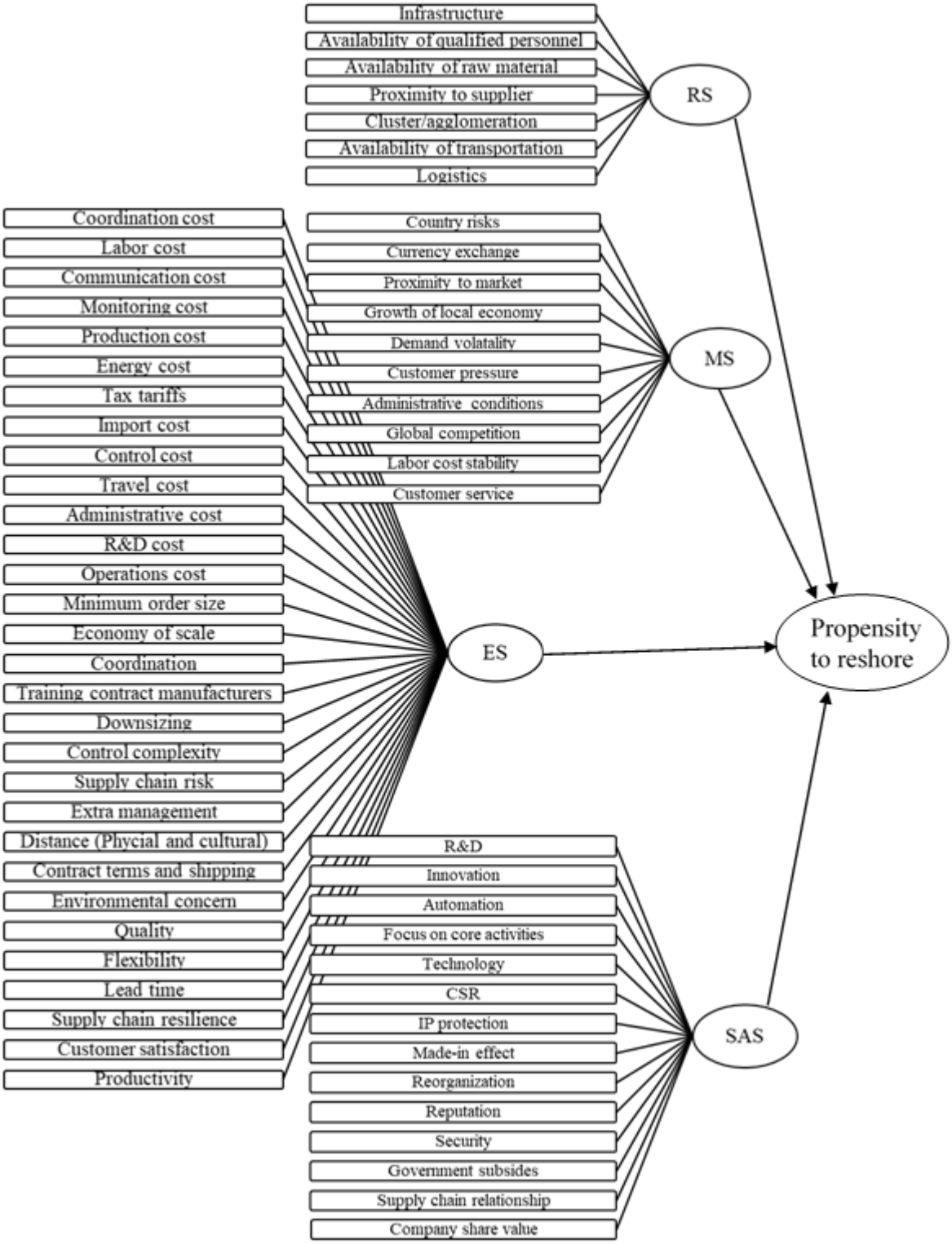
A company's initial production location decision to offshore manufacturing can influence their decision to reshore beyond the loss of expected cost advantages. The literature describes a number of other expected benefits including, a) a greater proximity to international suppliers and consumers, b) foreign incentives, and c) less government regulations in developing economies. These initiatives support all four MR, RS, ES, and SAS advantages. However, as the business and political environments change, the expected benefits based on the original offshoring motivations are reevaluated, leading companies to return production to their home country. This study refers to this reevaluation and repositioning of manufacturing decisions to meet company objectives as "right-shoring", which includes either offshoring or reshoring, and the right balance of domestic and foreign production.

From the perspective of sustainability, a company's objectives must include economic, social and environmental performance to be sustainable. In deference to the

majority of literature measuring social performance as charity or CSR, this study demonstrates that the impact of companies in the healthcare industry can be positive to the economy as well as society. Benefits occur through both direct and indirect influence on various stakeholders in society who support healthcare to individuals, positive corporate profits, and national economic growth. In this sense, reshoring as a right-shoring decision in recent years allows firms to consider a broader set of variables to achieve company objectives, and thus strengthen corporate sustainability.

The medical device and pharmaceutical industries have positive impacts on economic and social performance due to the importance of the healthcare industry that typically pays high salaries while improving human lives. Investment in the foreign manufacturing of these products, i.e. offshoring, is dominated by practices focusing on cost efficiency. However, over time other important factors appear to be harmed by this strategy, or the expected offsets for labor cost are no longer realized that relate to market, other resources, and strategic assets. This suggests that motivations to reshore may differ from the original objectives of offshoring. This causes firms to reevaluate the existing investments to achieve right-shoring. They are willing to consider partial or full reshoring to achieve the optimal balance between domestic and foreign manufacturing. The OLI framework can explain the conceptual use of right-shoring as a decision tool both at an empirical and analytical level. Figure 2 below is a conceptual model developed based on the findings from the literature review. The conceptual model categorizes reshoring drivers based on the four factors of location advantages.

Figure 2. Conceptual model from the literature



SEMI-STRUCTURED INTERVIEWS

Methodology

The semi-structured interview approach used in this study is recommended when the research is still somewhat exploratory and under-researched (Rowley, 2012), as in the case of reshoring decisions in healthcare. A theoretical foundation can provide structure to properly guide interview questions, but the range of possible answers in exploratory studies are not well defined. Twelve interviews were conducted in this study, which exceeds the recommended minimum of eight respondents, allowing for a thorough qualitative analysis (McCracken, 1988). The thoroughness of this type of research is often described as theoretical saturation (Robinson, 2014) when no new information is discovered.

An interview protocol is developed with questions based on the literature review and research objectives in line with recommendations by Walker et al. (2008) and Kvale and Brinkmann (2009). The procedure for the interview protocol development follows Jacob and Furgerson (2012). The interview questions are piloted on a professor and a Ph.D. student in the area of operations and supply chain management after an iterative review process by the authors. The interview questions obtain information on:

1) demographics of the interviewees and their organizations,
2) role of quality, regulation, and technology in medical device and drug manufacturing,
3) factors considered in location decisions for healthcare manufacturing, and
4) how these factors influence reshoring decisions.

The interviews are conducted face-to-face and last approximately 30 minutes. The interview log is recorded in writing and verified throughout the interview process by follow-up questions with the participants. If insufficient information was collected due to the interview setting, a follow up phone call or in person meeting was conducted for clarification. Nine interviews were conducted at a 2018 annual meeting of a medical device manufacturing association which included executives and managers. The selected interviewees represent a convenience sample from the participants who have expertise in the industry. They include mid to upper level management, i.e. senior managers, directors, and CEOs. The interviewees are knowledgeable in global sourcing and issues in manufacturing healthcare products due to their experience with relevant global companies as well as focal firms and suppliers. The organizations represented by the participants have manufacturing facilities located in the U.S. and/or overseas (e.g. India, China, Ireland, Sweden, etc.). Three additional interviews were conducted outside of the conference on two employees in pharmaceutical companies and one in medical device manufacturing, both of which are members of large size firms that serve global markets. Descriptive information on the interviewees and their organizations is provided in Table 2.

To avoid misinterpretation and maintain consistency in using the proper terminology in this research context, reshoring is defined to the interviewees as "moving manufacturing back to the country of its parent company" (Ellram, 2013, p.3). While not all twelve organizations have reshored their production, they periodically evaluate their domestic and/or foreign manufacturing decisions to ensure that their location strategies are still appropriate.

Table 2. Descriptive information of interviewees and organizations

No.*	Position	Primary products/ services	Company background
A	Director of Sales	Medical components (tubes, etc.)	Distributor of medical components
B	Principal	Consulting	Consulting process and quality improvement of medical device, pharmaceuticals and other regulated manufacturing industries
C	Director of sales	Silicone based surgical products	Supplier without R&D; Labor is the highest expense
D	Territory manager	Medical components, drugs, accessories/ supplies	Labor expense largest in the total expense, serve global market and many global manufacturing locations, Sweden for prototyping
E	Senior business development manager	Designing, developing and manufacturing MedTech devices (diagnostics, etc.)	R&D and manufacturing facilities in India and serving both India and U.S. market
F	Business development manager	Medical tubing	Contract manufacturer, serve 70% U.S. market and different countries (Malaysia, Ireland – specialization), automated
G	CEO	Dental supplies	Small business, labor intensive (manual jobs), products only manufactured in the U.S.
H	CEO	Medical device sterilizer	Operate only in the U.S.; provide sterilization to medical device manufacturers
I	Executive vice president	Blood management, medical products, pharmaceuticals, medical devices, cardiovascular systems, etc.	Global headquarter located in the U.S., a subsidiary of a Japanese multinational firm
J	Senior advanced quality engineer	Medical supplies for non-implantable devices (surgical products, syringes, needles, sterilization solutions)	Emphasis on automated manufacturing and mass production
K	Medicine team lead	Over the counter and prescription drugs	Global (Ireland, U.S., China, Brazil, Russia, Japan, etc.); made and sold at manufacturing locations
L	Supply chain planning team lead	Over the counter and prescription drugs	Global consumers, clinical trials, global (40% us, 40% EU, others)

No*: Each alphabet indicates different interviewees from different organizations.

Thus, questions particularly relevant to reshoring decisions are based on their propensity to reshore.

Among the interviewees, five of them are not directly involved in organization that manufacture medical devices. Their organizations provide service (i.e. sales and distribution) associated with medical devices. However, as CEOs and directors that are rather high level decision makers in the relevant industry and members of a medical device manufacturing and outsourcing organization, they have a solid understanding of manufacturing processes, issues, and relevant decisions in the medical device industry through their experience with partners in the supply chain.

Result and discussion

The results of the twelve interviews reveal important considerations for healthcare manufacturing in terms of reshoring decisions. The results find two variables that were not found in the literature review. They also emphasize variables that are identified as issues of current offshoring strategy in the healthcare manufacturing industry – quality and R&D. The findings from the interviews are described in the following section and a summary of the individual interview results is reported in Appendix F. The results are linked to the four factors of the theoretical framework – RS, MS, ES and SAS.

Quality and regulation

Quality is emphasized as an important factor in manufacturing processes in the healthcare industry. Companies in the medical device and pharmaceutical industries

particularly strive to achieve high quality of their products and deal with continuing safety issues due to their clinical impact on individuals.

Though achieving high quality in medical products is important, concerns about quality issues play a major role in location decisions only if product failures or defects occur. This is because foreign plants must go through a qualification process prior to being selected as a possible offshoring site. However, the repeated inability of a plant to solve its quality issues could result in reshoring. Only one interviewee responded, “location matters to quality achievement”. For example, quality issues are more likely to occur due to turnover in line-workers or inspectors rather than specific location traits. This is the case with regulatory requirements as well. Quality and regulation issues are closely related because firms are subject to government regulations and industry practices that require compliance with quality system standards. According to the World Health Organization (WHO) (2003), regulations for quality systems assure that the essential quality requirements are met. Conformity to the standards is verified through direct testing and certification. If a company serves international markets, it must meet these standards as well as local requirements. The Original Equipment Manufacturers (OEMs), suppliers, and contract manufacturers all follow these standards because the government and customers expect them to provide evidence of the product quality, and in some cases supplier selection guidelines. An FDA approval of relevant products as well as a manufacturer is difficult, so regulatory satisfaction is also considered an indicator of high quality. While these factors are important in production due to potential safety issues, they do not necessarily affect

their location decisions. Since the literature discusses quality and regulation as decision factors, they are included in the model.

Product specialization and customer requirements

Location decisions for medical device manufacturers are heavily influenced by product specialization. For example, some interviewees explained when production involves a high level of customization and specialization, or R&D capabilities, companies tend to maintain their manufacturing in home or high-tech locations (e.g. U.S., Sweden, Ireland, etc.). For example, among the interviewees, a senior manager from Company E with 26 different manufacturing and service locations said that the company has its R&D prototyping offshored to Sweden. The company also produces a wide range of products for global markets and its manufacturing locations are chosen depending on where they can find suppliers and contract manufacturers that are willing and able to manufacture what customers want. For the products whose manufacturing requirements do not exist in preferred locations, companies must locate based on the availability of resources needed for production. For example, Company G in the U.S. is a contract manufacturer and has manufacturing facilities located in Ireland. Despite Ireland being a costly place for manufacturing and far from the company's home country, products that are needed by its European customers can be developed and made in Ireland. Compared to typical consumer goods and other high-tech products, manufacturing medical devices and pharmaceutical products is highly customer driven, due to the effects on human health and relatively short shelf life. Thus, firms tend to have fewer options for favorable locations due to the limited

availability of manufacturers that specialize in those products. Thus, this implies that reshoring can be more attractive to the medical device and pharmaceutical companies if the home location has suppliers that have capacity and capability for products in their specialization. Customer requirements and markets are viewed as a MS factor, while locations that have high-skilled labor to produce customized and specialized products are viewed as a RS advantage.

Cost and risks

Cost is still an important factor for location decisions in both manufacturing and R&D, which explains the intense competition in the medical device markets. Offshoring can increase risk since less control typically occurs in the product development and manufacturing process. This explains how the interviewees described the higher likelihood of product failures and product testing costs. Thus, a large investment in offshoring R&D and increasing manufacturing costs impacts location decisions. To reduce product development and testing costs, firms seek low cost regions. For example, Company E designs and manufactures medical devices. The company manufactures in India which serves the local customers as well as the U.S. market. It is able to reduce costs by also offshoring R&D to India. However, while costs are lower, the quality of R&D is impacted. If reshored to the U.S., the resulting increase in R&D costs is one of the variables in their relocation decision. Seeking lower manufacturing and R&D costs is an ES factor, while countries that demonstrate lower risk can be considered a SAS advantage.

Product complexity and standardization

Interviewees uniformly mentioned that the impact of reshoring can depend on the type of products. Medical products can be as simple as generic tubes but can be as complicated as diagnostic devices. Thus, complexity can involve customization in manufacturing processes that impact location decisions. Healthcare companies represented in the interviews manufacture a wide range of products, with a small to large product volume, serving global customers. Their materials, manufacturing processes, the number of off-shored production and suppliers are highly variable. Products (especially components, parts, etc.) with low product complexity such as simple tubing or silicone bags are still manufactured in low labor cost regions.

However, production processes that are highly automated for mass production can be made in high labor cost regions. However, not all of the participants had highly standardized products that can be automated. They produce a variety of products, some of which have a high degree of complexity and technological requirements that necessitate significant involvement of skilled labor. Low complexity, highly standardized products can be made in countries that provide ES advantages. Highly complex products requiring more skilled labor or high tech automation are likely in countries that can provide resource and supply oriented advantages.

Opportunities and challenges of reshoring decisions

The interviewees responded that reshoring could benefit their firms by providing proximity to customers in their home country (MS), which subsequently reduces lead time and transportation costs (ES). Because they recognize that the U.S.

has the largest healthcare market in the world, U.S. based medical manufacturing companies can benefit from locating closer to market. This allows firms to shorten their lengthy supply chain process and logistics costs. The respondent from Company D particularly addressed that locating the manufacturing facilities to a home location would provide better control for the company. If issues occur in the manufacturing process, a prompt response would be possible. Furthermore, according to the manager from Company E which manufactures their products in India, customers tend to have positive perceptions about "Made-In- USA" products, but only one manager mentioned this as a factor in reshoring. Also, access to a skilled workforce is recognized as a RS opportunity.

Reshoring can be beneficial in regard to tariffs for SAS opportunities. One of the interviewees mentioned that through their experience manufacturing in China, changes in government policies affected tariffs imposed on their products, as they are currently experiencing the 2019 trade war between the U.S. and China. If reshored, firms can take advantage of favorable policies and stability in regulations. However, challenges of reshoring include high market competition and costs that can be higher than offshored regions. Especially for a firm that has offshored not only manufacturing but also the R&D process, there is a concern about increased R&D costs when reshored.

Summary

While the interviewees find a number of benefits and opportunities which can motivate them to move their manufacturing back home, none of the interviewed firms

have reshored recently. However, if issues such as poor quality occurs from their suppliers and contract manufacturers, they will make an effort to improve these issues or look for alternative suppliers in the current market. While they are able to still leverage manufacturing in low cost countries, the lengthy supply chain can result in long lead times. Reshoring is one way to shorten lead time. However, most of the interviewees indicate that they serve local customers in the offshored regions in addition to the U.S. market. In current strategies that are targeting international customers, the benefits of proximity to market from a supply chain perspective do not necessarily justify reshoring. Rather, these firms ensure that customers are aware of the longer lead times. As demonstrated in the literature, the initial decisions to offshore were driven by low labor costs in developing countries. This was also evident in the interviews since direct labor costs still make up the largest portion of total costs. While reducing costs in manufacturing is important to these firms, they did not see it as a consistent, dominating criteria that alone determines location decisions.

In addition, pharmaceutical manufacturers suggested that existing or growing demand in local market, an MS advantage, is a strong motivation for the drugs that have to be manufactured where they are sold. The two interviewees from major pharmaceutical companies are a small number compared to the number of interviewees from medical device manufacturers. However, the potential differences in these two industry sectors need further exploration.

With heavy competition, MS advantages (i.e. the first to introduce a new product to the market) are important in selling medical devices and pharmaceuticals. In that sense, locating where firms can produce their specialized products can be key

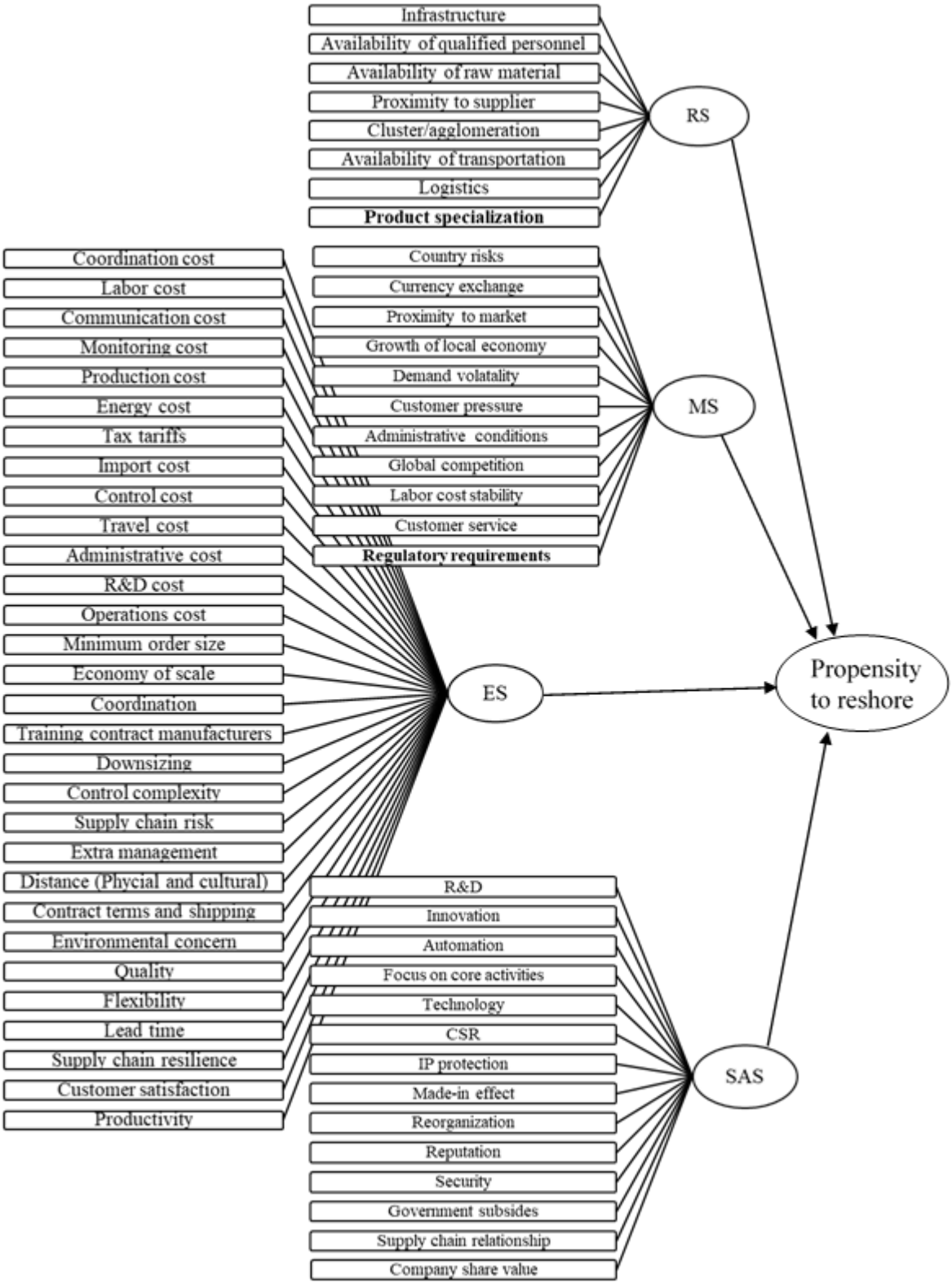
to firm performance, which has a greater effect on location decisions. These results suggest that current offshored firms in the medical device and pharmaceutical industry sectors are more likely to consider reshoring as a SAS decision when the original motivation for offshoring no longer exists. New emerging opportunities do not carry the same weight in decision-making as maintaining initial expectations. For example, they may reshore only if they can no longer satisfy customer-driven requirements in the offshored locations.

Lastly, the result of the semi-structured interview implies potential difference in emphasis on decision variables between the two industry sectors. A larger number of the interviewees represent medical device manufacturing decisions, which are based on cost and quality factors. As one interviewee from the pharmaceutical industry suggests, however, “demand in the local market is a critical factor relevant to the supply chain decision process”. This may be further investigated through the survey.

Conceptual model

The results of the interviews are incorporated in the conceptual model from the literature review. Based on the interview results, a conceptual model is reviewed and revised as shown in Figure 3. Figure 3 shows 65 variables measuring four factors, RS, MS, ES, and SAS. The revised conceptual model includes two additional variables, product specialization and regulatory requirement which is differentiated regulations related to tax benefits and tariffs.

Figure 3. Refined conceptual model



SURVEY

Methodology

Research design

A survey was developed, pre-tested, pilot-tested, and administered to respondents following Dillman's four step method (2009; 2014). The survey was developed based on the research question, the results of the literature review and semi-structured interviews, and reshoring-related studies that used a survey instrument (i.e. Johansson et al., 2018). The initial questionnaire was tested for readability, clarity, face validity, and content validity with a group of faculty and Ph.D. students in operations and supply chain management that have experience with empirical methods. After making several recommended changes, the survey instrument was pre-tested on the group of academics again and on 18 business practitioners in an MBA program (Pre-test 1). After the survey was refined, the second pre-test was conducted on a group of 14 mid-level managers in the pharmaceutical industry in the presence of the authors (Pre-test 2). During a group debriefing assessment (Ruel et al., 2016), the managers brought up some issues with respect to the number of questions and redundancy of the measurement items. A set of questions on reshoring indicators in particular was comprised of 65 items, which caused concerns about low response rate and overlaps in measurement among the items. Thus, a re-classification through a Q sort was recommended and performed with these 14 managers, and then with 17 new managers in the medical device industry using a Delphi approach, which reduced the reshoring indicators to 35 items. The first round of Q sort reduced 65 items to 54 items;

the second round of Delphi study reduced these to 35 items by seeking consensus based on 75% threshold (McKnight, 2008).

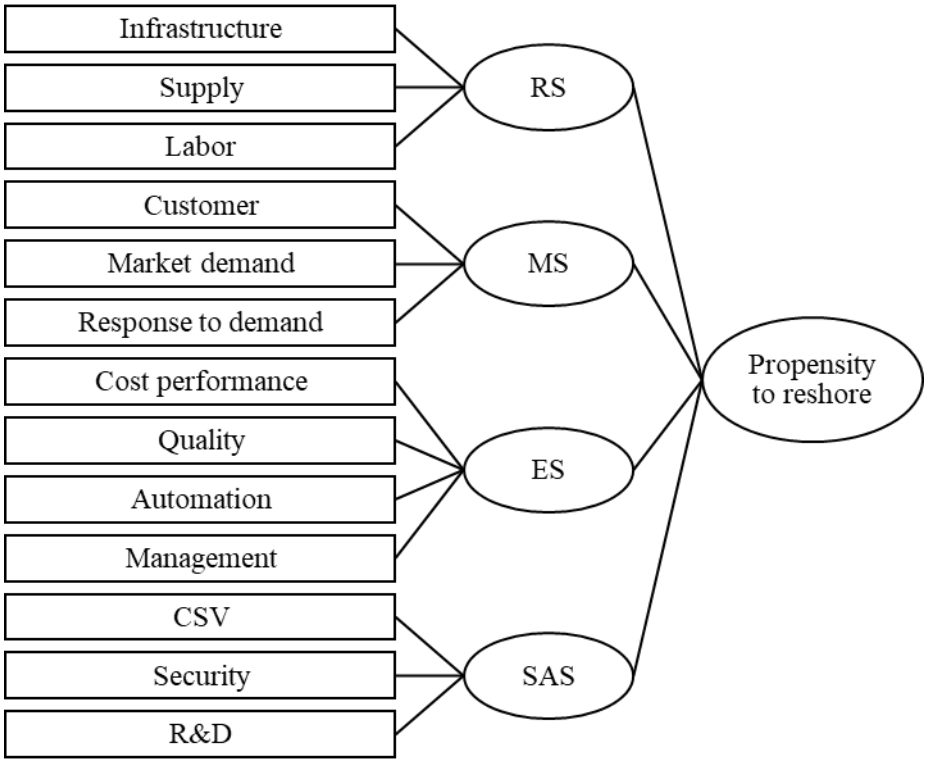
The revised instrument was piloted on a group of 16 employees from the medical device industry and 14 employees from the pharmaceutical industry (Pilot-test). The pilot-test group recommended only minor amendments in the survey instruction on the first page. However, there was no substantial change in the questions. The responses from the pilot-test are compared with the final survey responses for consistency and reliability (Armstrong and Overton, 1977). The final questionnaire consists of a total of 14 questions asking background and demographics of the survey respondents and their organizations, and 35 items of reshoring factors which form 13 variables. Questions on reshoring factors ask to what degree respondents agree with each statement using a 5-point Likert scale. The final survey instrument is provided in Appendix G.

Reevaluation of the proposed model

This section explains the Q sort used after Pre-test 2 as a classification method (McKnight, 2008) to refine survey items in the model. This process enables a re-evaluation of identified reshoring indicators in the proposed model and an identification of potential correlations among them. Two rounds of Q sort were conducted in this process. The first Q sort was conducted with practicing managers of Pre-test 2 group in the pharmaceutical industry using a Delphi approach (Brady, 2015). The participants were asked to categorize the items into different groups based on what each item purports to measure. Sixty-five items were classified into 15 different

groups, and those in the 15th group “others” were re-evaluated or removed, resulting in reduction of 65 to 54 items. The second round of Q sort was conducted to reach consensus on the conceptual classification of the participants. It was conducted on 17 managers from medical device manufacturers. Corresponding to the threshold of 75% consensus by McKnight (2008), items that obtained below 75% agreement were dropped. This results in 35 items that measure different reshoring motivations. Details on classified items through Q sort are presented in Appendix H, and a refined measurement model based on the result is shown in Figure 4. The re-evaluation and the refined model provide insights on how managers look at the variables in the decision making process. Because of their suggested relationships, first order and second order factors are supported in the measurement model. Each measurement item for the 13 variables and four factors is described in Appendix H with the Q sort result. The re-evaluation also results in the change of cost-related variables to non-ES advantages, for example, labor cost to RS advantage.

Figure 4. The revised measurement model from Q Sort



Survey administration

The survey is delivered online using Qualtrics which is a company that supports survey research services such as survey development, data collection (survey administration), and data analysis. The survey administration uses two different channels:

1) self-survey administration (participants are verified to work in relevant organizations by the researchers)
2) survey administration through a research firm

A combination of these two channels overcomes weaknesses underlying each of these survey administration approaches. For example, a self-administered survey is criticized for its inability to obtain a satisfactory sample size, while a paid survey

through a research firm involves a risk of misrepresented qualifications or data due to reward motives (Schoenherr et al., 2015). To improve these issues, this study employs both approaches. Differences in the survey administration procedures of each approach are described in Table 3.

Table 3. Description of survey administration procedures

	Self-administered survey	Research firm
Survey administration	Authors	Qualtrics
Survey platform	Qualtrics	Qualtrics
Survey method	Online	Online
Incentive	No incentive	Reward pay provided
Survey invitation	N/A	281 (survey accessed)
Responses collected	137	105
Data collection procedure	• Survey invitations were sent to pre-determined respondents. • Qualifications of respondents were verified by their affiliations with relevant organizations and associations (e.g. Association of U.S. medical device manufacturers)	• Qualifications based on "managers at Pharmaceutical/Medical Manufacturing firms – screened out "Individual Contributor" or "Entry Level" • An email invitation is sent to potential qualified respondents in panel informing research purpose, duration, incentive, etc. on a variety of platforms.

One issue that occurs with this combined survey administration approach is the difficulty in determining a response rate since it occurs through survey research firms. Survey invitations are sent to individuals by the authors and the survey firm only

provides information on the number of accessed surveys, which makes it difficult to determine a response rate.

Results and discussion

Sample analysis

A total of 242 responses were obtained. Sample demographics of the final sample of 186 respondents by job experience, firm size, and products are presented in Tables 4 – 8 below. Table 4 shows 74.2% of the sample companies that have reshored all or part of manufacturing (firm level) and/or are currently considering to reshore. Table 5 presents the levels of relevant manufacturing decisions made by the respondents in their firms, and the number of job experience in the relevant industry. 75.8% of the respondents participate in intermediate to very high levels of manufacturing related decision making. Table 6 shows the types of products made by the companies and firm sizes. Approximately 98% of the companies in the sample manufacture medical devices and/or drugs; half of these companies are large firms with more than 1000 employees. Table 7 shows the four product characteristics such as labor intensity, technology intensity, product standardization (customization), and product complexity. Table 8 shows the locations of headquarters and ownership of the sample companies. Over 85% of these firms have both ownership and headquarter locations in the U.S. The initial sample is explained in Section 4.2.2. A majority of participant organizations have reshoring experience or are currently considering reshoring decisions.

Table 4. Current reshoring experience and reshoring considerations of the sample companies

Reshoring	Frequency	Percent
No reshoring	48	25.8
Reshored/considering reshoring	138	74.2
Total	186	100.0

Decision level	Frequency	Percent	**Job Experience**	Frequency	Percent
None	16	8.6	<1 year	16	8.6
Very low	10	5.4	1-5 years	38	20.4
Low	18	9.7	6-10 years	49	26.3
Intermediate	48	25.8	11-15 years	36	19.4
Very high	93	50.0	16-20 years	46	24.7
Total	185	99.5	Total	185	99.5
N/A	1	.5	N/A	1	.5
Total	186	100.0	Total	186	100.0

Table 5. Relevant work experience of the sample respondents

Table 6. Product types and firm size of the sample companies

Product types	Frequency	Percent	**Firm size**	Frequency	Percent
Medical devices only	73	39.2	0-9 employees	2	1.1
Drugs only	69	37.1	10-49 employees	12	6.5
Both medical devices and drugs	40	21.5	50-249 employees	29	15.6
Involved in relevant decision making (e.g. sales)	2	1.1	500-999 employees	46	24.7
Not involved at all.	1	.5	1000-5000 employees	20	10.8
Total	185	99.5	5000 or more	76	40.9
N/A	1	.5	Total	185	99.5
Total	186	100.0	N/A	1	.5

Table 7. Product characteristics of the sample companies

	Product standardization		**Product complexity**		**Tech intensity**		**Labor intensity**	
Scale	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Very low	6	3.2	0	0	18	9.7	4	2.2
Low	18	9.7	29	15.6	25	13.4	42	22.6
Moderate	45	24.2	56	30.1	53	28.5	62	33.3
High	0	0	0	0	0	0	0	0
Very high	116	62.4	100	53.8	89	47.8	77	41.4
Total	185	99.5	185	99.5	185	99.5	185	99.5
N/A	1	.5	1	.5	1	.5	1	.5
Total	186	100.0	186	100.0	186	100.0	186	100.0

Table 8. Location of headquarters and ownership of the sample companies

Locations	**Headquarter**		**Ownership**	
	Frequency	Percent	Frequency	Percent
Non-U.S.	19	10.2	26	14.0
U.S.	165	88.7	159	85.5
Total	184	98.9	185	99.5
N/A	2	1.1	1	.5
Total	186	100.0	100.0	186

Descriptive statistics and data cleaning

The initial sample of 242 responses is obtained through the online survey and subjected to screening for incomplete responses and outliers. The first stage of data screening procedure involves an identification of suspect responses that can significantly affect data analysis. Of the 242 responses, 2 responses that recorded the initiation of the survey but did not have answers were deleted.

Table 9. Descriptive statistics of the final sample

Variable	Mean	Sum	Square	Deviation	Median	Range	Skewness	Kurtosis
VACSV	2.392	445	348.349	1.372	2	4	0.83	-0.453
VB1INFRA	4.328	805	212.995	1.073	5	4	-1.233	0.322
VB2TRANC	3.57	664	375.591	1.425	3	4	-0.293	-1.347
VC1RAWMA	4.274	795	247.016	1.156	5	4	-1.244	0.282
VC2PROXS	3.285	611	329.898	1.335	3	4	0.138	-1.267
VC3CONTM	4.247	790	286.624	1.245	5	4	-1.353	0.524
VD1ECONS	3.258	606	383.613	1.44	3	4	0.043	-1.391
VD2CORDC	4.339	807	261.661	1.189	5	4	-1.508	0.919
VD3PRODC	4.091	761	283.446	1.238	5	4	-0.877	-0.641
VD4IMPOR	4.253	791	279.124	1.228	5	4	-1.315	0.385
VD5INVMG	4.161	774	279.161	1.228	5	4	-1.046	-0.272
VD6FLEXI	2.962	551	312.737	1.3	3	4	0.469	-0.918
VD7PRODU	4.452	828	208.065	1.061	5	4	-1.741	1.965
VE1PRODS	3.763	699.848	363.542	1.402	5	4	-0.552	-1.114
VE2PROXC	3.22	599	423.962	1.514	3	4	0.064	-1.538
VE3MADEI	3	558	468	1.591	3	4	0.21	-1.543
VE4LEADT	4.333	806	257.333	1.179	5	4	-1.461	0.769
VF1POLIR	4.124	767	332.156	1.34	5	4	-1.132	-0.186
VF2ADMIN	3.78	703	339.962	1.356	5	4	-0.549	-1.006
VF3REGRE	4.565	849	187.726	1.007	5	4	-2.165	3.52
VF4GVTSU	4	744	328	1.332	5	4	-0.854	-0.69
VG1VOLDE	2.409	448	252.946	1.169	2	4	1.035	0.438
VG2GOVTP	3.78	703	369.962	1.414	5	4	-0.606	-1.038
VHENVT	2.699	502	277.14	1.224	2	4	0.749	-0.319
VI1LABOR	4.258	792	303.613	1.281	5	4	-1.388	0.449
VI2LABOR	3.704	689	378.737	1.431	5	4	-0.437	-1.351
VJ1CONTC	4.376	814	239.656	1.138	5	4	-1.568	1.212
VJ2DISTA	2.403	447	278.758	1.228	2	4	0.884	0.049
VJ3REORG	2.339	435	255.661	1.176	2	4	1.001	0.427
VK1IP	4.263	793	296.091	1.265	5	4	-1.356	0.332
VK2SECUR	4.317	803	278.285	1.226	5	4	-1.486	0.778
VLAUTOMA	3.624	674	375.656	1.425	3	4	-0.307	-1.45
VNQUALIT	4.468	831	222.306	1.096	5	4	-1.868	2.268

VO1RND	2.806	521.988	355.028	1.385	2.494	4	0.509	-0.971
VO2RNDCO	2.674	497.319	376.667	1.427	2	4	0.632	-0.929

Then, 16 “straight-liners”, which “occurs when survey respondents give identical (or nearly identical) answers to items in a battery of questions using the same response scale” (Kim et al., 2019, P. 214), were removed in consideration of their effect on data quality. Ten additional responses that were not qualified based on a screener question on job level, i.e. individual contributor were dropped. Ten disqualified responses are from participants that claimed their affiliated organizations did not manufacture medical devices or pharmaceutical products or are not involved in relevant decision making. This first stage eliminates 30 responses resulting in 212 responses. After deleting suspect and/or disqualified responses, a missing value analysis is conducted for imputation. Approximately .2% of data points are missing and these are imputed using EM imputation method in EQS as EM imputation is considered to produce less biased estimates (Musil et al., 2002). Finally, 26 repeated outliers, identified as an outliers more than once, are dropped.

The final sample of 186 responses are included in the analysis. Table 9 provides descriptive statistics of the final sample. Among 35 reshoring drivers, regulatory requirements (V3REGRE) and quality (VNQUALIT) were ranked as the top motivation for reshoring decisions, which is consistent with the findings from the interviews.

Result and discussion

Prior to conducting confirmatory factor analysis (CFA), exploratory factor analysis (EFA) is conducted for each factor using SPSS to seek the underlying

structure of the measurement items (Tokman et al., 2006). The measurement items with low correlations are dropped from the factors and the measurement model is reconfigured. Table 10 presents the initial 35 items included in EFA.

Table 10. Initial measurement items before EFA

Reshoring drivers	**Factors**	**n/a**
Infrastructure	RS	Location advantage
Availability of qualified personnel		
Availability of raw material		
Government subsidies		
Transportation cost	MS	
Production cost		
Labor cost		
Import cost		
Proximity to supplier	ES	
Clusters		
Political risks		
Government subsidies		
Quality		
Inventory management		
Control and coordination		
Administration cost		
Coordination and communication cost		
Lead time		
Productivity		
IP		
Security		
Reorganization		
Economies of scale		
Automation		
Distance		
R&D capability	SAS	
Proximity to customers		
Made-in effect		
Proximity to suppliers		
R&D cost		
Company share value		

The final measurement model includes four to eight items in each factor with the total number of 20 measurement items in the reconfigured model. The result of the model fit assessment of the modified model is presented in Table 11. The CFI is .94 and RMSEA is close to .082, both of which indicate a good fit. The results show a good fit of the revised measurement model and the hypothesized relationships between measurement items and factors. The detailed model description and coefficient estimates of each item and variable are presented in Figure 5. The positive estimates suggest positive relations of the variables and the items. The survey results indicate the empirical relationship between the variables and factors that affect location decisions. However, the contribution of R&D to the SAS is somewhat weaker than other variables. This provides an important managerial implication because currently a large number of medical devices and pharmaceutical companies still move to countries such as China and India for lower R&D costs in addition to manufacturing costs.

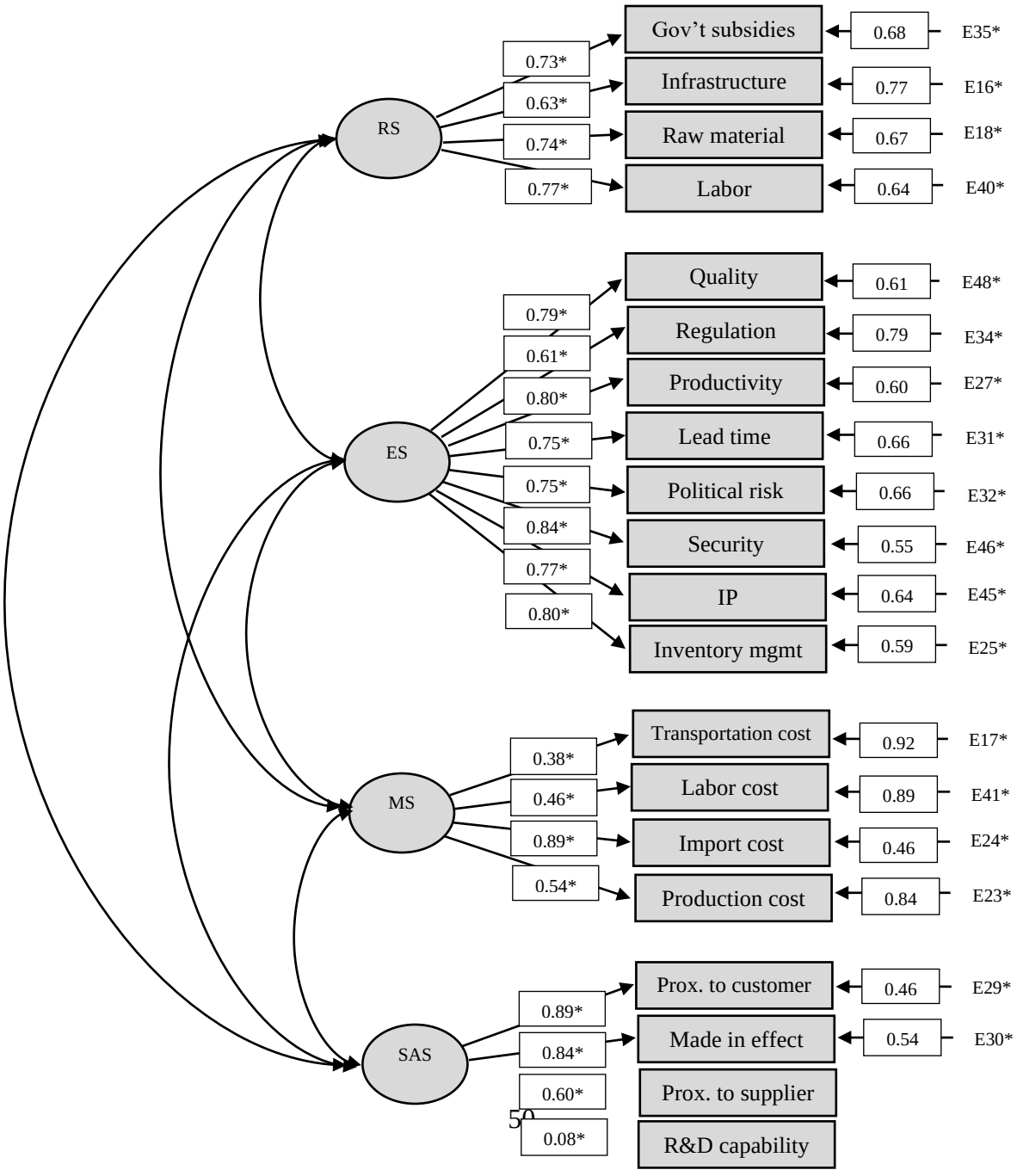
Table 11. CFA result fit indices of the measurement model

Fit indices	
Adjusted chi-square	146.47
Degrees of freedom	190
Bentler-Bonett Normed Fit Index (NFI)	0.897
Comparative fit index (CFI) – Robust	0.940
Root mean-square error of approximation (RMSEA) – Robust	0.082
Cronbach's alpha	0.901

The relationship between R&D location and quality issues needs further investigation. However, this may suggest that low R&D expenditure in the current

offshore region is perceived to be a barrier that impacts economic performance related to company share values at the risk of quality problems. The survey results for each group, pharmaceutical companies versus medical device companies, were compared and presented no significant differences between the groups.

Figure 5. Factor loadings of CFA result – modified CFA model



The findings from this study provides a framework that informs decision-makers in the medical device and pharmaceutical manufacturing industry. While the generalizability of the decision model may be limited because of the contextual focus of this study on manufacturing in the healthcare industry, it contributes to the literature in two major aspects. First, this study using the four sub-paradigms of the OLI framework contributes to the literature by empirically testing the theoretical framework to extend the applicability of the theory to business practice. Second, this study fills a research gap by providing an industry-specific decision framework that incorporates differences in decision factors among various industry sectors.

ANALYTICAL MODEL

Using the results of the interviews, several parameters are discovered that support the development of a rudimentary analytical model with an optimal solution. While an empirical investigation of this study finds factors such as quality and regulation as important considerations for reshoring decision, the analytical model focuses on the difference in the transportation cost and the resulting total cost of a location decision. The objective function is the minimization of total costs. This model is considered rudimentary because it is the first attempt to develop an optimal right-shoring solution based on the available real-world data. It does not claim to be robust because there may be other variables that can be included as more information is known. The model complements the empirical findings by providing a cost factor, transportation cost, which was rather less emphasized in the previous cost-based location decision. While this rudimentary analytical model uses the variables found through the literature review and interviews, it does not demonstrate the important factors such as quality and regulatory issues as a cost differentiator in this model. It is because quality and regulatory issues can vary by regions rather than being domestic or foreign.

Objective Function:

Total cost = {[Annual demand/(Order quantity/Fixed order cost)]/[Unit cost*Transportation cost]} + [(Order quantity/2)*Transportation cost]

$$TC = \{[D/(Q/FC)]/[C*T]\} + (Q/2)*T$$

Where:

d = domestic location (reshoring option)

f = foreign location (no reshoring option)

TC = total cost; where TCd is compared to TCf and the location decision is based on the lowest total cost.

D = annual demand (forecast), is uniform across locations

C = unit cost, varies by location

FC = fixed order cost, varies by location

Q = order quantity, is not limited by location

OF = order frequency, is stated in time units and can vary by location

T = Transportation cost, is stated as a percentage of C and varies by location

The assumptions of the model are as follows:

1) Quality: Since quality in reshoring is considered essential, no location will be considered that cannot meet minimum quality standards. Therefore, quality is treated as a qualifier in this model and thus considered as uniform across all possible locations. A quality variable may be represented as a factor in demand forecasts by adding a safety stock value to the basic forecast that represents additional production need to cover defective goods (or a defect percentage); however, none of the interviews shared their quality records so it is not included in this model.
2) Location (L): It is assumed that manufacturers have at least one domestic and one foreign location option when considering reshoring.

3) Manufacturing: It is assumed that a company controls the manufacturing schedule regardless of the locations. This includes a company-owned process or a contract manufacturer.
4) Customer demand (D): It is assumed that customer demand or demand forecast is not affected by location.
5) Inventory: The interviews revealed that drugs and medical devices have short shelf lives and thus are shipped just in time. Thus, it is assumed that holding costs are uniform across location.
6) Service levels: Service levels are considered uniform across all locations. The interviews revealed that regulators and customers to not tolerate out of stock items. Companies will spend more on transportation to prevent late orders and stock-outs.
7) Transportation cost (T): Companies will spend more on transportation to keep service levels high. It is often expressed as a function of unit costs in managerial accounting. Foreign locations are considered to have higher transportation costs than domestic production due to the distance from the market (locating to serve the local customers is not considered in the model due to variability among manufacturers).
8) Production: All locations are considered to be available for production for 250 days per year and 24 hours per day. This accommodates the typical availability for developed countries in Europe, Asia, and North America.
9) Fixed order cost (FC): It can vary by location.

10) Order quantity (Q): It can vary but should be based on an optimal quantity considering the minimization of transportation and ordering costs.

An example below demonstrates a hypothetical situation of how a firm will decide to right-shore based on the analytical model above. It is assumed that:

1) Quality is equal, comparable labor/technology 2) At least 1 foreign and 1 domestic option

3) Contract manufacturing avoids large initial investment

4) Annual forecast does not depend on location and is stable

5) No significant inventory holding cost due to JIT

6) Service levels are equal, transportation costs are the differentiator.

7) Transportation cost can be represented as a function of C, which represents the time differential.

8) Production days = 250 days/year, 24/5

9) Foreign location provides lower total manufacturing costs.

1) Total cost of domestic (d) production (TCd)

TCd = {[1,000,000/(20,000*5,000)]/(100*.25)}+[(20,000/2)*(100*.25)] = 250,000

Where:

Annual forecast (F) = 1,000,000 units

Unit cost (Cd) = $100/unit

Fixed cost per order (FCd) = $5,000

Order size (Qd) = $\sqrt{[(2 * 1{,}000{,}000 * 5{,}000)/(100 * 0.25)]}$ = 20,000 units

Transportation cost (Td) = 25% of unit cost = $25

Order Frequency = 1 week, minus 2 weeks for holidays = 50 orders/year.

Orders ship every 5 days.

2) Total cost of foreign (f) production (TCf)

TCf= {[1,000,000/(7,071*1,000)]/(40*1.0)}+[(7,071/2)*(40*.1.0)] =

141,420.10

Sf=1,000, [1,000,000/(7,071*1,000)]+[(7,071/2)*(40*1)] = 141,420.14

Sf=5,000, [1,000,000/(7,071*5,000)]+[(7,071/2)*(40*1)] = 141,420.03

Sf=5,000, [1,000,000/(7,071*5,000)]+[(7,071/2)*(70.71*1)] = 249,995.23

Where:

Annual forecast (F) = 1,000,000 units

Unit cost (Cf) = $40/unit, including customs and tariffs

Fixed cost per order (FCf) = $1,000

Order size (Qf) = $\sqrt{[(2 * 1{,}000{,}000 * 1{,}000)/(40 * 1)]}$ = 7,071 units

Transportation cost (Tf) = 100% of unit cost = $40Order Frequency = 42 hours, minus 2 weeks for holidays = 142 orders/year. Orders ship every other day.

3) Right shoring

TCd = TCf @ FCf= $1,000 and C = $70.71

This example demonstrates that when the total cost per unit is below $70.71, a manufacturer will choose to offshore production. At $70.71 or higher unit cost, a manufacturer will choose to reshore. However, foreign production does allow for more flexibility with smaller, more frequent ordering. This also implies that with increasing labor cost in foreign locations and tariffs imposed upon imported products, firms may re-evaluate their total cost analysis and location decisions.

CONCLUSION

This study attempts to develop and empirically test the OLI framework as a theoretical grounding that explains the expected benefits of offshoring and reshoring in the context of the healthcare manufacturing industry. The literature review identified a number of reshoring motivations in the extant literature and found no research focusing on a specific industry, particularly in the context of healthcare. In spite of the number of articles that attempted to develop an empirically tested reshoring decision model, studies were limited to reshoring frameworks based on a "one-size-fits-all" approach. As the global healthcare market extensively grows, the importance of manufacturing products that support healthcare services has increased. In that sense, this study fills the research gap in current reshoring literature by examining reshoring motivations of the medical device and pharmaceutical industries. A major theoretical contribution is to empirically test the theoretical framework, the OLI, which had only been used to conceptually explain and categorize the current motivations for location decisions as competitive advantages. The semi-structured interviews found the importance of emphasized factors such as quality, regulatory requirements, and product specialization on current location decisions.

The results of the survey find that quality and regulatory requirements contribute to current and future reshoring decisions, which is consistent with the findings from the literature and interviews. The CFA results suggest that R&D capability has a positive but weak relationship with strategic asset advantages that can lead to reshoring decisions. This result can be understood in a way that managers in the medical device industry and pharmaceutical manufacturers see R&D in offshore

regions as an opportunity as opposed to reshoring. Furthermore, this may reflect offshoring practices in the medical device and pharmaceutical industries due to the availability of R&D outside the home country and even at a lower cost (e.g. India). However, this also provides important managerial implications for practicing managers. While offshoring for lower R&D costs helps offset rising product costs, product recalls according to the FDA continue for various quality issues including non-sterility, cracks, leakage, identification of potential safety issues, etc., which may potentially lead to a higher cost in the long term.

Finally, the analytical model in this study incorporates the impact of transportation costs and the resulting total cost on estimating parameters that lead to optimal right-shoring decisions. The example reflects the current reshoring consideration in recent years as firms realize the impact of transportation costs on their initial total cost analysis that focused on low labor and manufacturing cost in foreign locations. Since the manufacturing cost started increasing in some developing economies such as China and the issues from offshoring occurred (e.g. quality), the importance of re-evaluating the total cost analysis has been addressed. The model is limited in that firms are assumed to have reshoring production as the only alternative to foreign production while in reality this may also lead to further offshoring decisions to where the total cost estimate is lower.

The findings of this study make several practical implications. This study simplifies the existing reshoring decision frameworks by providing an industry-specific reshoring model based on the location advantages. Business managers may use the model to evaluate and prioritize factors involved in reshoring beyond cost

factors. Likewise, policy makers can benefit from this study to understand the factors that contribute to reshoring decisions and, thus, to make relevant policies to encourage reshoring or discourage offshoring as a way to promote domestic production for growth in the local economy. Lastly, this study contributes to sustainability by extending the domain of social and economic sustainability to reshoring. It suggests that social benefits can be achieved outside of the traditional charitable activities through a firm's location decision that can also sustain economic performance.

LIMITATION AND FUTURE RESEARCH DIRECTION

This study makes a contribution to the literature and business practice by suggesting an empirically tested reshoring model. However, there are several limitations that suggest future research directions.

First, future research can increase the sample size. The number of responses obtained in this study satisfies the recommended sample size for analysis. However, a larger sample size can increase the effect size and improve the model fit. Related to this, future studies may consider a survey administration approach that provides a determinate response rate to improve statistical validity.

Another future research effort can be made in terms of the scope of the study. Even within the same product category, the product complexity varies and requirements in the manufacturing process for each type of product can vary. For example, among the medical device companies, the level of product complexity varies determining labor intensity and ability to automate manufacturing processes. This can vary to a greater extent for larger firms that provide a wide range of product lines. Further investigation on this matter can be done using field research or in-depth interviews.

Also, the proposed analytical model is limited focusing on the transportation cost and resulting total cost as the only differentiator. It is noted that quality and regulatory requirements vary by each region rather than by manufacturing in domestic country or foreign location. However, future studies can propose an advanced analytical model by incorporating parameters that can differentiate quality and regulation factors.

Lastly, while this study stresses the need of industry or product specific investigation on reshoring decisions, future studies can test the proposed model in different contexts. With the criticism on the OLI framework that is considered contextual with limited generalizability, the theoretical framework has been mostly used for a conceptual understanding of international investment decisions (i.e. Ellram et al., 2013; Ancarani et al., 2015). Empirical tests of factors impacting location decision as an investment decision can help validate generalizability of the OLI framework in international location decisions to various industry sectors.

APPENDICES

Appendix A. Codification of the systematic literature review (SLR)

Classification codes	
A	**Research methodology**
A1	Analytical
A2	Theoretical (Conceptual)
A3	Literature review
A4	Survey
A5	Case study
A6	Experiment
A7	Quantitative (Statistical analysis)
A8	Interview
B	**Research type**
B1	Journal
B2	Thesis
B3	Conference proceedings
B4	White paper
B5	Industry paper
C	**Journal**
C1	Operation Management Research
C2	Journal of Business Research
C3	Cambridge Journal of Regions, Economy and Society
C4	Journal of World Business
C5	International Journal of Production Economics
C6	Journal of Manufacturing Technology Management
C7	Journal of Purchasing & Supply Management
C8	Journal of Operations Management
C9	International Journal of Traffic and Transportation Engineering
C10	Operations and Supply Chain Management
C11	Growth and Change
C12	Industrial Marketing Management
C13	International Journal of Physical Distribution & Logistics Management
C14	Journal of Engineering Manufacturing
C15	Management
C16	International Journal of Production Research
C17	Supply Chain Forum: An International Journal

C18	Business Horizons
C19	Manufacturing & Service Operations Management
C20	International Journal of Management Cases
C21	Journal of Textile and Apparel, Technology and Management
C22	International Business and Global Economy
C23	International Journal of Operations & Production Management
C24	Journal of the Academy of Marketing Science
C25	Competition and Change
C26	Journal of Supply Chain Management
C27	Strategic Outsourcing: An International Journal
C28	European Business Review
E	**Definition of reshoring**
E1	Home country (backshoring)
E2	Relocation (reshoring)
F	**Context/country**
F1	United States
F2	Europe
F3	Asia
F4	Others
F5	Single country (regional)
F6	Multiple countries (international)
G	**Reshoring perspective**
G1	Location decision
G2	Sourcing decision (governance mode)
G3	Others
H	**Reshoring types**
H1	Backshoring for outsourcing
H2	Backshoring for insourcing
H3	In house backshoring
H4	Outsourced backshoring
H5	Non-backshoring for outsourcing
H6	Non-backshoring for insourcing
H7	In house non-backshoring
H8	Outsourced non-backshoring
I	**Research theme**
I1	Reshoring motivations/drivers
I2	Reshoring decision framework

I3	Impact of reshoirng
I4	Reshoring process
I5	Impact on reshoring
J	**Unit of analysis**
J1	Single reshoring decision/specific activity
J2	Firm
J3	Production
J4	Product
J5	Reshoring volume
J6	Country
J7	Individual (customer)
K	**Documentation**
K1	Questionnaire
K2	Interview
K3	Document analysis
K4	Public data
K5	Press information (e.g. newspaper)
K6	Bibliography
L	**Term**
L1	Reshoring
L2	Re-shoring
L3	Inshoring
L4	Nearshoring
L5	Backshoring
L6	Onshoring
L7	Rightshoring
L8	Back-reshoring
O	**Time frame**
O1	Temporal
O2	Longitudinal
P	**Reshoring initiation**
P1	Correction (offshoring failure)
P2	Reactive decisions
P3	Strategic change

Appendix B. Result of the systematic literature review (SLR)

Authors	Baraldi et al. (2018)	Grappi et al. (2018)	Heikkila et al. (2018)	Stentoft et al. (2018)
Journal	C12	C4	C6	C5
Research methodology	A5	A4, A8	A4	A4, A7
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E1	E1	E1
Context/Country	F2	F1, F2 (Italy)	F2 (Finland)	F2 (Denmark)
Reshoring perspective	G1	G1	G1	G1
Reshoring types	H4, partial	n/a	n/a	n/a (captive or insourcing)
Research theme	I4	I3, (demand perspective)	I1	I3
Unit of analysis	J1	I7	J2	J2
Documentation	K2	K1, K2	K1	K1, K4
Term	L1	L1	L5	L5
Time frame	O2	O1	O1	O1
Reshoring initiation	Strategic change	Strategic change (value creation)	Strategic change	Correction
Healthcare (Med device or product)	No	n/a	Yes (parmaceuticals1 .3%)	n/a

Authors	Vanchan et al. (2018)	Albertoni et al. (2017)	Brandon-Jones et al. (2017)	Chen & Hu (2017)
Journal	C11	C4	C8	C19
Research methodology	A2	A4	A7	A1
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E2	E1	E1
Context/Country	F1, F2 (UK)	F6	F1	F1
Reshoring perspective	G1, G2	G1	G1	G2
Reshoring types	H2, H3, H4, H8	n/a	H1, H2, H3, H4	n/a
Research theme	I1	I4	I3	I5
Unit of analysis	J1	J2	J2	J4
Documentation	K6	K4	K4, K5	n/a
Term	L1	L1	L1	L1
Time frame	n/a	O2	O2	n/a
Reshoring initiation	Strategic change	Both	Strategic change	Strategic change
Healthcare (Med device or product)	No		No	No

Authors	Delis et al. (2017)	Gray et al. (2017)	Hartman et al. (2017)	Kim et al. (2017)
Journal	C2	C8	C18	C9
Research methodology	A4	A5	A5	A1
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E1	E1	E1
Context/Country	F2, F6	F1	F1	F1
Reshoring perspective	G1	G1, G2	G1, G2	G1
Reshoring types	H2, H3	H2, H4	n/a	n/a
Research theme	I1	I1, I2	I2	I3
Unit of analysis	J2	J3	J4	J5
Documentation	K4	K2	K2	K4
Term	L2	L1	L1, L4	L1
Time frame	O2	O1	O1	O1
Reshoring initiation	Strategic change	Reactive decision (offshoring experience/external environment changes)	Reactive decision (non-strategic)	Reactive decision (to demand change)
Healthcare (Med device or product)			n/a	

Authors	Tate and Bals (2017)	Wiesmann et al. (2017)	Abbasi (2016)	Ashby (2016)
Journal	C13	C28	C21	C1
Research methodology	A2	A3	A2	A5
Research type	B1	B1	B1	B1
Definition of reshoring	E2	E1	E1	E1
Context/Country	n/a	F2 (Germany)	F1	F2 (UK)
Reshoring perspective	G1, G2	G1	G1	G1, G2
Reshoring types	H1, H2, H3, H4, H5, H6, H7, H8	n/a (H1, H2, H3, H4 – Gray et al. (2013))	n/a	H1, H2, H3, H4
Research theme	I2	I1	I1	I2, I3
Unit of analysis	J1		J1	J1
Documentation	K6	K6	K5, K6	K2
Term	L1, L4, L7	L1	L1, L7	L1
Time frame	n/a	n/a	n/a	O2
Reshoring initiation	Strategic change	n/a	Strategic change	Strategic change
Healthcare (Med device or product)	No	n/a	No	No

Authors	Foerstl et al. (2016)	Fratocchi et al. (2016)	Joubioux & Vanpouke (2016)	Lavissiere et al. (2016)
Journal	C13	C13	C1	C17
Research methodology	A2	A2	A5	A5
Research type	B1	B1	B1	B1
Definition of reshoring	E2	E1	E1	E1
Context/Country	n/a	F6	F6 (F1, F2)	F1, F2 (Mauturis)
Reshoring perspective	G1, G2 (reshoring and insourcing)	G1	G1	G1
Reshoring types	H1, H2, H3, H4, H5, H6, H7, H8 (nearshore – exclude offshore)	n/a (H1, H2, H3, H4)	H2, H4, H6, H8	n/a
Research theme	I1	I1	I2	I5
Unit of analysis	J2	J1	J1	J3
Documentation	K3, K6	K4, K5, K6	K2	K2
Term	L1	L1	L2, L7	L5
Time frame	n/a	O1	O1	O2
Reshoring initiation	Strategic change/correction	Correction	Correction (failure)	Correction (failure)
Healthcare (Med device or product)	n/a	No	No	No

Authors	Mlody (2016)	Moradlou & Backhouse (2016)	Ocicka (2016)	Presley et al. (2016)
Journal	C22	C14	C15	C17
Research methodology	A2	A3	A4	A3, A7
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E1	E1	E1
Context/Country	F2	F2 (UK)	F2 (Poland)	n/a
Reshoring perspective	G1	G1, G2	G1, G2	G1, G2
Reshoring types	n/a	H1, H2, H3, H4	H1, H2, H3, H4	n/a
Research theme	I1	I1	I1, I3	I2, I4
Unit of analysis	J6	J3	J3	J1
Documentation	K6	K6	K1	K3, K6
Term	L1	L2	L1	L1
Time frame	n/a	n/a (O1)	n/a (O1)	O1
Reshoring initiation	Reactive decisions & Strategic change	Correction (failure)	Correction (failure)	Strategic change
Healthcare (Med device or product)	n/a		n/a	n/a

Authors	Robinson & Hsieh (2016)	Srai & Ane (2016)	Stentoft et al. (2016a)	Stentoft et al. (2016b)
Journal	C1	C16	C1	C1
Research methodology	A5	A3	A4, A5	A3
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E1	E1	E1
Context/Country	F2 (UK)	F2 (UK, France)	F2 (Denmark)	n/a
Reshoring perspective	G1	G1	G1, G2	G1
Reshoring types	H1, H2, H3, H4 (H2)	n/a	H3	n/a
Research theme	I3	I1	I1	I1
Unit of analysis	J1	J1	J1	n/a
Documentation	K2	K6	K1, K2	K6
Term	L1	L1	L5	L5
Time frame	O2	n/a	O1	n/a
Reshoring initiation	Correction (failure)	Strategic change	Reactive decisions	Reactive decisions
Healthcare (Med device or product)	No	n/a		n/a

Authors	White & Borchers (2016)	Zhai et al. (2016)	Ancarani et al. (2015)	Brennan et al. (2015)
Journal	C10	C1	C5	C23
Research methodology	A4	A7	A7	A2
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E1	E1	E1
Context/Country	n/a (F1)	F1	F2, F6	F2 (Germany)
Reshoring perspective	G1	G1	G1, G2	G1
Reshoring types	n/a	H1, H2, H3, H4	n/a	n/a (H2, H4)
Research theme	I1, I2	I1, I5	I1	I1, I5
Unit of analysis	J1	J1	J1	J1
Documentation	K1	K4, K5	K5	K6
Term	L1	L1	L1	L2, L5
Time frame	O1	O2	O2	n/a
Reshoring initiation	Strategic change	Reactive decisions	Correction (exit of offshoring)	Strategic change
Healthcare (Med device or product)	No	No	n/a	No

Authors	Grappi et al. (2015)	Gylling et al. (2015)	Arlbjorn & Mikkelsen (2014)	Bailey & De Propris (2014)
Journal	C24	C5	C7	C3
Research methodology	A6	A5 (action research)		A2
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E1		E2
Context/Country	F2(Italy)	F2 (Finland)	F2 (Denmark)	F1, F2 (UK)
Reshoring perspective	G1	G1		G1
Reshoring types	n/a, partial vs. full reshoring	H2, H3 (in-house)		H1, H2, H3, H4
Research theme	I5	I2	I1 (notes and debates)	I1
Unit of analysis	J7	J3		J2
Documentation	K1, K2	n/a (K2)		K5, K6
Term	L1	L5	L5	L1
Time frame	O1	O2	n/a	n/a
Reshoring initiation	Strategic change (consumer driven)	Strategic change	n/a	Strategic change
Healthcare (Med device or product)	No	No	n/a	No

Authors	Bailey & De Propris (2014)	Fratocchi et al. (2014)	Kinkel (2014)	Martinez-Mora & Merino (2014)
Journal	C3	C7	C7	C7
Research methodology	A2	A2	A4	A8/A5
Research type	B1	B1	B1	B1
Definition of reshoring	E1	E2	E1	E2
Context/Country	F2 (UK)	n/a	F2 (Germany)	F2 (Spain)
Reshoring perspective		G1	G1, G2	G1
Reshoring types			H1, H2, H3, H4 (exit mode only – not specified reshoring modes)	H1, H2, H3, H4 (manufacturing: outsourcing, production: in-house)
Research theme	I1		I1 (notes and debates)	I1
Unit of analysis			J2	J2
Documentation	K2, K6	K6	K4	K2
Term	L1	L8	L5	L1
Time frame	n/a		O2	O1
Reshoring initiation		Strategic change/ reactive decisions (environmental)	Correction (short-term)	Reactive decisions (environment)
Healthcare (Med device or product)	No	n/a	No (Metal and electrical - whole manufacturing)	No

Authors	Mezzadri (2014)	Tate (2014)	Tate et al. (2014)	Canham & Hamilton (2013)
Journal	C25	C7	C18	C27
Research methodology	A2		A4	A4
Research type	B1	B1	B1	B1
Definition of reshoring			E2	E1
Context/Country	F3 (India)	F1	F1	F4 (New Zealand)
Reshoring perspective			G1	G1
Reshoring types			n/a	n/a
Research theme	I3	I1	I1	I1, I5
Unit of analysis			J2	J2
Documentation	K6		K1	K1
Term	L5		L!	L5
Time frame	O1		O1	O1
Reshoring initiation			Reactive decisions (changes in the environment)	Strategic change
Healthcare (Med device or product)	No		Yes	n/a

Authors	Ellram (2013)	Ellram et al. (2013)	Gray et al. (2013)	Kinkel (2012)	Kinkel & Maloca (2009)
Journal	C26	C26	C26	C23	C7
Research methodology		A4	A2	A4, A7	A4
Research type	B1	B1	B1	B1	B1
Definition of reshoring			E1	E1 (include relocation)	E1
Context/Country		F1 – F6	F1	F2 (Germany)	F2 (Germany)
Reshoring perspective		G1	G1	G1, G2	G1
Reshoring types		n/a (owned manufacturing facilities)	H1, H2, H3, H4	n/a (H1, H2, H3, H4, H5, H6, H7, H8	n/a
Research theme	Editorial	I1	I4	I1	I1
Unit of analysis		J2	J2	J2	J2
Documentation		K1	K6	K4	K1, K4
Term		L1, L4	L1	L5	L5
Time frame		O1	n/a	O2	O2 (reshoring as O1)
Reshoring initiation		Strategic change	Correction	Strategic change	Correction (failure)
Healthcare (Med device or product)		n/a	n/a	Yes (medical, precision and optical instruments)	Yes (medical, precision and optical instruments)

Appendix C. Articles by industry sectors

ISIC Code	Food products, beverages and tobacco	Textile, textile products, leather and leather products	Wood and wood products	Pulp, paper and paper products	Publishing and printing
Kinkel & Maloca (2009)	V	V	V	V	V
Kinkel (2012)	V	V	V	V	V
Canham & Hamilton (2013)					
Bailey & De Propris (2014a)					
Bailey & De Propris (2014b)					
Kinkel (2014)					
Martinez-Mora & Merino (2014)		V			
Mezzadri (2014)		V			
Tate et al. (2014)	V	V			
Ancarani et al. (2015)					
Brennan et al. (2015)					
Gylling et al. (2015)					
Abbasi (2016)		V			
Ashby (2016)		V			
Foerstl et al. (2016)					
Fratocchi et al. (2016)	V	V			
Joubioux & Vanpouke (2016)					
Ocicka (2016)		V			
Robinson & Hsieh (2016)		V			
Stentoft et al. (2016a)					
Zhai et al. (2016)	V	V	V		
Albertoni et al. (2017)					
Brandon-Jones et al. (2017)		V			V
Chen & Hu (2017)					
Delis et al. (2017)	V	V	V	V	V
Gray et al. (2017)		V			
Hartman et al. (2017)					
Kim et al. (2017)	V	V	V		
Baraldi et al. (2018)		V			
Heikkila et al. (2018)	V	V	V	V	
Johansson & Olhager (2018)	V		V	V	
Johansson et al. (2018)	V		V	V	
Vanchan et al. (2018)	V	V	V		

ISIC Code	Chemicals, chemical products and man-made fibers	Rubber and plastics	Other non-metallic mineral products	Basic metals and fabricated metal products	Machinery and equipment n.e.c.
Kinkel & Maloca (2009)	V	V	V	V	V
Kinkel (2012)	V	V	V	V	V
Canham & Hamilton (2013)					
Bailey & De Propris (2014a)					
Bailey & De Propris (2014b)					
Kinkel (2014)				V	
Martinez-Mora & Merino (2014)					
Mezzadri (2014)					
Tate et al. (2014)	V				V
Ancarani et al. (2015)					
Brennan et al. (2015)				V	
Gylling et al. (2015)					
Abbasi (2016)					
Ashby (2016)					
Foerstl et al. (2016)					
Fratocchi et al. (2016)					
Joubioux & Vanpouke (2016)					
Ocicka (2016)	V				
Robinson & Hsieh (2016)					
Stentoft et al. (2016a)					
Zhai et al. (2016)	V		V	V	
Albertoni et al. (2017)					
Brandon-Jones et al. (2017)	V	V			V
Chen & Hu (2017)					
Delis et al. (2017)	V	V	V	V	V
Gray et al. (2017)				V	
Hartman et al. (2017)					
Kim et al. (2017)				V	V
Baraldi et al. (2018)					
Heikkila et al. (2018)	V	V	V		V
Johansson & Olhager (2018)	V	V		V	V
Johansson et al. (2018)	V	V	V	V	V
Vanchan et al. (2018)		V	V	V	

ISIC Code	Electrical machinery and apparatus n.e.c.	Office machinery, computers and communication equipment	Medical, precision and optical instruments, etc.	Transport equipment	Furniture; manufacturing n.e.c.; recycling
Kinkel & Maloca (2009)	V	V	V	V	V
Kinkel (2012)	V	V	V	V	V
Canham & Hamilton (2013)					
Bailey & De Propris (2014a)					
Bailey & De Propris (2014b)					
Kinkel (2014)	V				
Martinez-Mora & Merino (2014)					
Mezzadri (2014)					
Tate et al. (2014)	V	V	V		
Ancarani et al. (2015)	V				
Brennan et al. (2015)	V				
Gylling et al. (2015)				V	
Abbasi (2016)					
Ashby (2016)					
Foerstl et al. (2016)					
Fratocchi et al. (2016)	V				V
Joubioux & Vanpouke (2016)					
Ocicka (2016)					V
Robinson & Hsieh (2016)					
Stentoft et al. (2016a)					
Zhai et al. (2016)			V		
Albertoni et al. (2017)					
Brandon-Jones et al. (2017)	V			V	V
Chen & Hu (2017)					
Delis et al. (2017)	V			V	V
Gray et al. (2017)				V	
Hartman et al. (2017)					
Kim et al. (2017)	V	V		V	
Baraldi et al. (2018)					
Heikkila et al. (2018)			V	V	V
Johansson & Olhager (2018)	V	V			
Johansson et al. (2018)	V	V	V	V	
Vanchan et al. (2018)		V		V	

ISIC Code	Consumer goods	Industrial goods	Automotive	Aerospace and defense	Pharma and biotech	Services	Construction	Others
Kinkel & Maloca (2009)								
Kinkel (2012)								
Canham & Hamilton (2013)	V	V						
Bailey & De Propris (2014a)			V					
Bailey & De Propris (2014b)			V					
Kinkel (2014)								
Martinez-Mora & Merino (2014)								
Mezzadri (2014)								
Tate et al. (2014)			V	V	V	V	V	V
Ancarani et al. (2015)			V					
Brennan et al. (2015)								
Gylling et al. (2015)								
Abbasi (2016)								
Ashby (2016)								
Foerstl et al. (2016)								
Fratocchi et al. (2016)			V					V
Joubioux & Vanpouke (2016)				V				
Ocicka (2016)			V					
Robinson & Hsieh (2016)								
Stentoft et al. (2016a)							V	
Zhai et al. (2016)								
Albertoni et al. (2017)						V		
Brandon-Jones et al. (2017)						V		
Chen & Hu (2017)								
Delis et al. (2017)					V			V
Gray et al. (2017)								
Hartman et al. (2017)								
Kim et al. (2017)								V
Baraldi et al. (2018)								
Heikkila et al. (2018)			V		V			V
Johansson & Olhager (2018)			V					V
Johansson et al. (2018)			V					
Vanchan et al. (2018)						V		V

ISIC Code	Biomedical/ medical	Electronics	Mechanical	Home appliances	Measuring, analyzing, controlling instruments	Repair and installation of machinery and equipment	Hobbies/ Toys
Kinkel & Maloca (2009)							
Kinkel (2012)							
Canham & Hamilton (2013)							
Bailey & De Propris (2014a)							
Bailey & De Propris (2014b)							
Kinkel (2014)							
Martinez-Mora & Merino (2014)							
Mezzadri (2014)							
Tate et al. (2014)							
Ancarani et al. (2015)							
Brennan et al. (2015)							
Gylling et al. (2015)							
Abbasi (2016)							
Ashby (2016)							
Foerstl et al. (2016)							
Fratocchi et al. (2016)	V	V	V	V			V
Joubioux & Vanpouke (2016)							
Ocicka (2016)		V					
Robinson & Hsieh (2016)							
Stentoft et al. (2016a)							
Zhai et al. (2016)		V			V		
Albertoni et al. (2017)							
Brandon-Jones et al. (2017)							
Chen & Hu (2017)							
Delis et al. (2017)						V	
Gray et al. (2017)					V		
Hartman et al. (2017)							
Kim et al. (2017)	V						
Baraldi et al. (2018)							
Heikkila et al. (2018)						V	
Johansson & Olhager (2018)							
Johansson et al. (2018)							
Vanchan et al. (2018)		V					V

*References with no industry focus are excluded in the table.

Appendix D. Reshoring drivers in the literature

No.	Factors	Citations and References
1	Flexibility	Kinkel & Maloca (2009), Kinkel (2012), Canham & Hamilton (2013), Kinkel (2014), Brennan et al. (2015), Gylling et al. (2015), Fratocchi et al. (2016), Robinson & Hsieh (2016), Stentoft et al. (2016a), Stentoft et al. (2016b)
2	Quality	Kinkel & Maloca (2009), Kinkel (2012), Canham & Hamilton (2013), Gray et al. (2013), Arlbjorn & Mikkelsen (2014), Bailey & De Propris (2014a), Bailey & De Propris (2014b), Kinkel (2014), Ancarani et al. (2015), Brennan et al. (2015), Gylling et al. (2015), Fratocchi et al. (2016), Joubioux & Vanpouke (2016), Mlody (2016), Moradlou & Backhouse (2016), Presley et al. (2016), Stentoft et al. (2016a), Stentoft et al. (2016b) Zhai et al. (2016)
3	Coordination cost	Kinkel & Maloca (2009), Kinkel (2012), Canham & Hamilton (2013), Brennan et al. (2015), Mlody (2016), Moradlou & Backhouse (2016), Robinson & Hsieh (2016), Stentoft et al. (2016a)
4	Infrastructure	Kinkel & Maloca (2009), Brennan et al. (2015), Mlody (2016), Srai & Ane (2016)
5	Availability of qualified personnel	Kinkel & Maloca (2009), Kinkel (2012), Canham & Hamilton (2013), Kinkel (2014), Tate et al. (2014), Brennan et al. (2015), Fratocchi et al. (2016), Srai & Ane (2016), Stentoft et al. (2016a), White & Borchers (2016), Zhai et al. (2016), Albertoni et al. (2016)
6	Ability to deliver on time	Kinkel (2012), Canham & Hamilton (2013), Martinez-Mora & Merino (2014), Ancarani et al. (2015), Brennan et al. (2015), Fratocchi et al. (2016)
7	Labor cost	Kinkel (2012), Canham & Hamilton (2013), Ellram et al. (2013), Bailey & De Propris (2014a), Kinkel (2014), Tate (2014), Tate et al. (2014), Fratocchi et al. (2016), Mlody (2016), Moradlou & Backhoue (2016), Ocicka (2016), Robinson & Hsieh (2016), Srai & Ane (2016), Stentoft et al. (2016a), White & Borchers (2016), Zhai et al. (2016)
8	Monitoring cost	Kinkel (2012), Brennan et al. (2015)
9	Communication cost	Canham & Hamilton (2013), Srai & Ane (2016)
10	Logistics	Ellram et al. (2013), Bailey & De Propris (2014b), White & Borchers (2016)
11	Switching cost	Ellram et al. (2013), White & Borchers (2016)

12	Raw material	Ellram et al. (2013), Srai & Ane (2016), White & Borchers (2016)
13	Country risk (global/political uncertainty, environmental, social/ethical, natural disaster, regulation)	Ellram et al. (2013), Presley et al. (2016), Srai & Ane (2016), White & Borchers (2016)
14	Government trade policies (tax, trade requirements)	Ellram et al. (2013) Joubioux & Vanpouke (2016) Srai & Ane (2016) – political stability, natural disaster White & Borchers (2016)
15	Tax rates	Gray et al. (2013), Tate et al. (2014)
16	Tariffs	Gray et al. (2013), Stentoft at al. (2016a)
17	Currency exchange	Ellram et al. (2013), Gray et al. (2013), Bailey & De Propris (2014a), Tate et al. (2014), Joubioux & Vanpouke (2016), Mlody (2016), Moradlou & Backhoue (2016), Ocicka (2016), Srai & Ane (2016), White & Borchers (2016)
18	Clusters/agglomeration	Gray et al. (2013)
19	Distance (cultural, psychic, institutional)	Gray et al. (2013), Tate (2014), Mlody (2016) - cultural Robinson & Hsieh (2016), Srai & Ane (2016) – psychic
20	Lead time	Arlbjorn & Mikkelsen (2014), Tate et al. (2014), Joubioux & Vanpouke (2016), Robinson & Hsieh (2016), Zhai et al. (2016)
21	Automation	Arlbjorn & Mikkelsen (2014), Tate (2014), Mlody (2016), Srai & Ane (2016), Stentoft et al. (2016a), Stentoft et al. (2016b), Zhai et al. (2016)
22	Focus on core activities	Arlbjorn & Mikkelsen (2014), Stentoft et al. (2016a)
23	R&D	Arlbjorn & Mikkelsen (2014), Kinkel (2014), Brennan et al. (2015), Ashby (2016), Joubioux & Vanpouke (2016), Robinson & Hsieh (2016), Srai & Ane (2016), Stentoft et al. (2016a)
24	Logistics/Transportation cost	Bailey & De Propris (2014a), Kinkel (2014), Tate et al. (2014), Brennan et al. (2015), Fratocchi et al. (2016), Ocicka (2016), Robinson & Hsieh (2016), Srai & Ane (2016), Stentoft et al. (2016a), Zhai et al. (2016)
25	Supply chain/supply chain resilience	Bailey & De Propris (2014a), Bailey & De Propris (2014b), Joubioux & Vanpouke (2016), Presley et al. (2016), Srai & Ane (2016), Stentoft et al. (2016a), Wiesmann et al. (2017)
26	Cost (total)	Bailey & De Propris (2014b), Tate (2014), Ancarani

		et al. (2015), Abbasi (2016), Fratocchi et al. (2016), Ocicka (2016), Robinson & Hsieh (2016), Stentoft et al. (2016b), Zhai et al. (2016), Albertoni et al. (2017), Kim et al. (2017)
27	Skilled workforce	Bailey & De Propris (2014b), Joubioux & Vanpouke (2016)
28	Responses to customers	Bailey & De Propris (2014b), Tate (2014)
29	Technology	Bailey & De Propris (2014b), Gylling et al. (2015), Ocicka (2016), Srai & Ane (2016)
30	Operations cost	Bailey & De Propris (2014b)
31	(Customer) services	Bailey & De Propris (2014b), Ancarani et al. (2015), Fratocchi et al. (2016), Srai & Ane (2016)
32	Innovation	Bailey & De Propris (2014b), Tate (2014), Fratocchi et al. (2016), Joubioux & Vanpouke (2016), Mlody (2016), Robinson & Hsieh (2016), Albertoni et al. (2017)
33	Turnover	Bailey & De Propris (2014b)
34	Coordination	Kinkel (2014)
35	Know-how	Kinkel (2014), Brennan et al. (2015), Srai & Ane (2016), Stentoft et al. (2016a)
36	Proximity to home	Kinkel (2014)
37	Increase in domestic production (replenishments)	Martinez-Mora & Merino (2014)
38	Increase in new products	Martinez-Mora & Merino (2014)
39	Failure in market	Martinez-Mora & Merino (2014), Foerstl et al. (2016), Albertoni et al. (2017)
40	CSR	Mezzadri (2014)
41	Surplus warehouse/manufacturing space	Tate (2014)
42	Productivity	Tate (2014), Mlody (2016), Moradlou & Backhouse (2016), Srai & Ane (2016), Stentoft et al. (2016a)
43	IP protection (risk)	Tate (2014), Fratocchi et al. (2016), Joubioux & Vanpouke (2016), Mlody (2016), Moradlou & Backhouse (2016), Ocicka (2016), Stentoft et al. (2016a), Zhai et al. (2016)
44	Shipping requirement	Tate (2014)
45	Energy cost	Tate (2014), Tate et al. (2014), Moradlou & Backhouse (2016), Ocicka (2016)

46	Labor cost stability	Tate et al. (2014), White & Borchers (2016)
47	Transportation availability	Tate et al. (2014), Mlody (2016), Moradlou & Backhouse (2016)
48	Proximity to customers	Tate et al. (2014), Ancarani et al. (2015), Fratocchi et al. (2016), Mlody (2016), Srai & Ane (2016), Stentoft et al. (2016a)
49	Made in effect	Ancarani et al. (2015), Fratocchi et al. (2016), Mlody (2016), Stentoft et al. (2016a)
50	Government incentives	Ancarani et al. (2015), Stentoft et al. (2016a), Zhai et al. (2016)
51	Capacity utilization	Brennan et al. (2015), Fratocchi et al. (2016)
52	Import cost	Gylling et al. (2015)
53	Production cost	Gylling et al. (2015), Mlody (2016)
54	Cost competitiveness	Gylling et al. (2015)
55	Demand fluctuation/volatility (seasonality)	Gylling et al. (2015), Stentoft et al. (2016a)
56	Sourcing risk	Gylling et al. (2015)
57	Training contract manufacturers	Gylling et al. (2015)
58	Growth of local economy	Ashby (2016)
59	Proximity to supplier	Ashby (2016)
60	Environmental uncertainty	Forestl et al. (2016)
61	Relational issues	Forestl et al. (2016)
62	Asset specificity	Forestl et al. (2016)
63	Reorganization	Fratocchi et al. (2016)
64	Cost efficiency	Fratocchi et al. (2016)
65	Termination of supply relationships	Fratocchi et al. (2016)
66	Minimum order size	Fratocchi et al. (2016)
67	Control complexity	Fratocchi et al. (2016), Zhai et al. (2016)
68	Subsides for relocation	Fratocchi et al. (2016)
69	Lack of local market attractiveness	Fratocchi et al. (2016)
70	Counterfeiting	Fratocchi et al. (2016)

71	Absence of local suppliers	Fratocchi et al. (2016)
72	Customer duties for re-import	Fratocchi et al. (2016)
73	Unions' pressure at the home country	Fratocchi et al. (2016)
74	Adaptation to customer needs & reliability	Joubioux & Vanpouke (2016)
75	Competitive advantage	Joubioux & Vanpouke (2016)
76	Unbeneficial legal-administrative conditions	Mlody (2016)
77	Investment incentives	Mlody (2016)
78	Proximity to market	Mlody (2016), Srai & Ane (2016)
79	Control cost	Mlody (2016), Robinson & Hsieh (2016)
80	Supply chain risk	Mlody (2016), Stentoft et al. (2016a), White & Bochers (2016)
81	Inventory	Moradlou & Backhouse (2016), Srai & Ane (2016), Zhai et al. (2016)
82	(extra) Management	Moradlou & Backhouse (2016), Stentoft et al. (2016b)
83	Travel cost	Moradlou & Backhouse (2016)
84	Environmental legislations	Moradlou & Backhouse (2016)
85	Communication	Moradlou & Backhouse (2016)
86	(Inter) cultural difference	Moradlou & Backhouse (2016)
87	Language barrier	Moradlou & Backhouse (2016)
88	Supply chain relationship	Ocicka (2016)
89	Environmental concern	Ocicka (2016), Presley et al. (2016), Srai & Ane (2016), Zhai et al. (2016)
90	Lean supply chain	Ocicka (2016)
91	Supply chain disruption	Ocicka (2016)
92	NPV	Presley et al. (2016)
93	Company share value	Presley et al. (2016)
94	Coordination	Presley et al. (2016)
95	Reputation/image/brand	Presley et al. (2016), Zhai et al. (2016)
96	Local incentives	Srai & Ane (2016)

97	Relationships/network	Srai & Ane (2016)
98	Economies of scale	Srai & Ane (2016)
99	Security	Srai & Ane (2016), Stentoft et al. (2016b)
100	Contract terms	Srai & Ane (2016)
101	Raw material cost	Srai & Ane (2016)
102	Administrative cost	Srai & Ane (2016)
103	Product development	Srai & Ane (2016)
104	Downsizing and rationalization	Srai & Ane (2016)
105	Hidden cost	Srai & Ane (2016)
106	Vertical integration	Srai & Ane (2016)
107	Location branding for traceability of the product	Srai & Ane (2016)
108	Location branding for quality image	Srai & Ane (2016)
109	Location branding for local social impact	Srai & Ane (2016)
110	Better traceability of products	Srai & Ane (2016)
111	Actual cost	Stentoft et al. (2016a)
112	Production and delivery reliability	Stentoft et al. (2016a)
113	Shrinking market size	Stentoft et al. (2016a)
114	Patriotism/loyalty	Stentoft et al. (2016a)
115	Correction of misjudged decision	Stentoft et al. (2016a)
116	Bureaucracy	Stentoft et al. (2016b)
117	Production basis	Stentoft et al. (2016b)
118	Strategic access	White & Borchers (2016)
119	Response to demand	Zhai et al. (2016)
120	Lean manufacturing	Zhai et al. (2016)
121	Firm specific locational advantage	Delis et al. (2017)
122	Global competition	Wiesmann et al. (2017)

Appendix E. Codification of the interview responses

No.	Q3	Q4	Q5	Q6
A	- Deal with patients - Material specification	- Quality and regulation often go hand in hand - Regulation designed to force product to be required quality level - Technology varies	- Availability of raw materials - Environment - Quality is most important	- These do not impact much
B	n/a	- Quality and regulation are important and need simultaneously - Technology can differ from company to company	- Availability of raw material - Skilled workforce - Regulatory assessment process - Environment	- All these impact location decision
C	- It varies product to product	- Regulation has more impact because it forces to meet the minimum quality level	- Quality	- Product specialization; products and location are customer-driven
D	n/a	- Technology depends on the complexity of products	- Product specialization	- It impacts performance; you can provide the product that customers want
E	n/a	- Not so much of quality issues currently - Technology depends on products	- Cost - Tariffs (e.g. China)	- Tariffs can affect price changes
F	- Higher quality and regulatory requirements	- Quality and regulation especially impact a lot on manufacturing process	- R&D cost - Labor cost does not impact a lot	- It impacts performance; technology varies by product type
G	n/a	- Quality matters more than low labor cost	- Availability and cost of labor	- It impact net profit
H	n/a	- Quality matters; regulation is required	- Availability of labor	- It can impact productivity and capability

I	- Innovation - Technology - Serviceability - Quality standards - Safety and effectiveness	- Quality, regulation, and technology all have big impact on firm performance - Market review process and verification and validation before and after use by FDA and other country requirements	- Cost (affordability – price) - Cost, quality, regulation, and technology together	- Proximity to R&D - Proximity to customers - Business sustainability (continuity of operations) - Better perception - Assurance of product to customers
J	- Highly regulated - Daunting documentation requirements - Direct impact on individuals (death, severe impairment	- Quality and regulation have more impact than technology	- Raw materials	- Technology - Tax incentive - Raw material (and sterilization)
K	- Impact on human being and safety	- Quality and regulation are highly important e.g. manufacturing facilities in Europe are investigated and highly regulated by EU - Technology is needed to the extent it is sufficient to manufacturing products	- Delivery (lead time) - Timing - Capacity	- Intellectual property (IP) - Labor cost - Government regulations - Capacity - Market demand
L	- Products (drugs) are sold in the location that is approved by healthcare authority country - Timing of product introduction is critical	- Quality is the most important and placed based on customer demand - Technology is easy to transfer over the borders	- Customer demand	- Manufacturing cost - Transportation cost

No.	Q7	Q8	Q9	Q10
A	- Cost (transportation)	- Impact on the firm performance in regard to environment, policy, and cost	With reshoring - Price	- Product development process (faster, better control)
B	- Skilled workforce	- Location matters to firm performance due to regulatory process	With offshoring - IP protection issues, R&D in developing economy (e.g. India) does not work well, difficulty in control	- Skilled workforce
C	n/a	- Impact on product quality	n/a	- Quality over labor cost (high labor turnover rate in foreign locations)
D	- Quality does not have so much impact on the location decision	- Location does not necessarily impact on financial performance	With offshoring - Longer lead time specified to customers, With reshoring - Cost, market competition, good customer perception	- Product specialization - Expertise - Factors are not so much market oriented (production ability)
E	- Cost	- Location does not impact a lot	With offshoring - Currently not so much of control or quality issues	- Cost
F	- Quality - R&D cost	- Location impacts on profits and availability of specialized suppliers and contract manufacturers	With offshoring - Not so much of quality issues because of the required quality system standards	- Production specialization
G	- Labor cost (manufacturing labor intensive products)	- Location does not impact a lot	With reshoring (domestic operations) - Obtaining high quality and low cost labor is difficult	- Quality - Low labor cost
H		- Impact on employee turnover rate	With offshoring and reshoring, - Employee turnover (keeping trained employees)	- Availability of labor - Labor cost
I	- Supply chain - Cost	- Impact on productivity – cost, quality, product, and	With reshoring - Business continuity - Proximity to customers	- Core competency

		profit	- Better customer perception - Natural disaster	
J	- Sourcing (Production time, expertise, low cost)	- Minimal impact on firm performance - Can impact in terms of government tariffs	With offshoring - Communication: language barrier and time difference - Expertise - Regulatory process With reshoring - Less communication issue - Better control - Better regulatory inspection access but difficult process	- Cost - Manufacturing environment
K	- Quality	- Impact on the supply chain	With offshoring - Being able to work with government agencies e.g. China - Regulations are not clear or established in some locations With reshoring - Expertise is increased - Reliability and familiarity - Better oversight - Less quality concern - Better security - May lack production capacity - Increasing cost	- IP - Government regulation - Quality
L	- Demand - Regulation	- Impact on cost performance because drug prices are fixed by the government in some countries	With offshoring - Availability and low cost of raw material - Increasing demand - Low cost operation sites With reshoring - Rising demand in neighboring countries e.g. Canada, Mexico - Tax benefits - Import and export cost - Increasing operating cost - Challenges to meet global demand in one location	- Demand - Technology

Appendix F. Interview questions

1) Background (job title)
2) Company background (industry, primary products, etc.)
3) What are the distinct characteristics of medical devices or drugs compared to other manufacturing industry sectors (e.g. automotive)?
4) How do quality, regulation, and technology impact decisions made in the manufacturing process?
    a. What is the regulation(s) that your company particularly has to deal with if there is any?
5) What other factors affect medical device or drug manufacturing?
6) What are the roles of these factors in manufacturing location decision?
7) What are the factors considered the most and least important in this decision and why?
8) How does manufacturing location impact on product or firm performance?
9) If currently offshored, what are the primary opportunities and/or challenges in the current location and home country?
10) What are/would be the main criteria that affect location decision of your company?

Appendix G. Survey questions

1. Has your company reshored from the previous offshored region(s)?

    a) Yes

    b) No

    c) I don't know

2. Is your company currently considering reshoring part or all of your manufacturing?

    a) Yes

    b) No

    c) I don't know

3. What is your job title in the company?

    _____

4. Which of the following best describes your level in the company?

    a) Owner/Director/CEO

    b) Upper management (President, Vice president, etc.)

    c) Middle management

    d) Lower management/Supervisory

    e) Technical

5. To what level do you participate in manufacturing decision making of your company?

    a) None b) Very low c) Low d) Intermediate e) High f) Very high

6. How many years of job experience do you have in the industry?

    a) Less than 1 year

    b) 1 – 5 years

    c) 6 – 10 years

    d) 11 – 15 years

    e) 16 – 20 years

    f) 20 years or more

7. Does your company manufacture medical devices or drugs?

    a) Medical devices only
    b) Drugs and other pharmaceutical products only
    c) Both medical devices and drugs
    d) I don't know
    e) No, but we are involved in decision making related to manufacturing these products (e.g. sales).
    f) No, we are not involved in any of these products.

8. Please rate the following product characteristics of the primary product(s) produced by your company.

Product complexity	a) very low b) low c) moderate d) high e) very high
Product standardization	a) very low b) low c) moderate d) high e) very high
Technology intensity	a) very low b) low c) moderate d) high e) very high
Labor intensity	a) very low b) low c) moderate d) high e) very high

9. Where does your company manufacture product(s)? Select all that apply.

    a) U.S.
    b) North America (non-U.S.)
    c) South America
    d) Asia
    e) Europe
    f) Africa
    g) Others (Please specify.) _____

10. Where is the majority of your product(s) sold?

    a) U.S.
    b) North America (non-U.S.)
    c) South America
    d) Asia
    e) Europe
    f) Africa

g) Others (Please specify.) _____

11. What is the country where your company headquarters are located?

    a) U.S.

    b) Others (Please specify.) _____

12. What is the country of ownership of your company (home country)?

    a) U.S.

    b) Others (Please specify.) _____

13. What is the total number of employees in your company?

    a) 0 – 9 employees

    b) 10 – 49 employees

    c) 50 – 249 employees

    d) 250 – 499 employees

    e) 500 – 999 employees

    f) 1000 – 5000 employees

    g) 5000 or more employees

14. Following are about factors that are involved in reshoring decisions. Please rate each factor based on its impact on reshoring decisions in your company.

Items	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Company share value	1	2	3	4	5
Infrastructure (e.g. transportation, logistics, information systems, etc.)	1	2	3	4	5
Transportation cost	1	2	3	4	5
Availability of raw materials	1	2	3	4	5
Proximity to suppliers	1	2	3	4	5
Ability to manage contract manufacturers in offshored location(s)	1	2	3	4	5
Economies of scale (cost advantage through a large volume of production)	1	2	3	4	5
Coordination and communication cost to process information from/to manufacturing in offshored location(s)	1	2	3	4	5

Production cost (except labor) with manufacturing in offshored location(s)	1	2	3	4	5
Import cost to/from offshored location(s)	1	2	3	4	5
Inventory management	1	2	3	4	5
Flexibility in manufacturing	1	2	3	4	5
Productivity	1	2	3	4	5
Level of product specialization	1	2	3	4	5
Proximity to market or customers	1	2	3	4	5
Customer perception of “Made in” home country (e.g. USA) products	1	2	3	4	5
Lead time	1	2	3	4	5
Political risk (e.g. instability, regime change, etc.) in offshored location(s)	1	2	3	4	5
Administrative conditions and cost in offshored locations	1	2	3	4	5
Regulatory requirement for products imported to or sold in home country (e.g. FDA)	1	2	3	4	5
Government subsidies for relocation	1	2	3	4	5
Reponses to volatile demand in home country	1	2	3	4	5
Government pressure to voluntarily produce goods in home country	1	2	3	4	5
Environmental concerns (e.g. pollution) in offshored location(s)	1	2	3	4	5
Supply chain disruptions	1	2	3	4	5
Lack of qualified labor in offshored location(s)	1	2	3	4	5
Labor cost in offshored location(s)	1	2	3	4	5
Ability to control and coordinate with manufacturing	1	2	3	4	5
Distance (physical distance and/or perceived difference) with offshored location(s)	1	2	3	4	5
Reorganization of the company (e.g. downsizing)	1	2	3	4	5
Potential intellectual property (IP) theft in offshored location(s)	1	2	3	4	5
Security in offshored location	1	2	3	4	5
Being able to automate manufacturing process	1	2	3	4	5

Product quality in offshored location(s)	1	2	3	4	5
Research and development (R&D) capability	1	2	3	4	5
R&D cost	1	2	3	4	5
Economic environment in home country	1	2	3	4	5
Industry clusters	1	2	3	4	5
Market competition	1	2	3	4	5
Currency exchange rate	1	2	3	4	5
Corporate social responsibility (CSR) practice in offshored location(s)	1	2	3	4	5

Appendix H. Classification of items through Q sort

No.	Items	Group	Variable
1	Company share value	A	CSV
2	Product complexity	A	n/a
3	Product standardization	A	n/a
4	Poor infrastructure (e.g. transportation, logistics, information systems, etc.) in offshored location(s)	B	Infrastructure
5	High transportation cost in offshored location(s)	B	Infrastructure
6	Lack of raw materials in offshored location(s)	C	Supply
7	Proximity to suppliers	C	Supply
8	Requirement and management of contract manufacturer in offshored location(s)	C	Supply
9	Economies of scale (cost advantage through a large volume of production)	D	Cost performance
10	High coordination cost to process information from/to manufacturing in offshored location(s)	D	Cost performance
11	High production cost (except labor) with manufacturing in offshored location(s)	D	Cost performance
12	High import cost to/from offshored location(s)	D	Cost performance
13	Difficulty in inventory management in offshored location(s)	D	Cost performance
14	Low flexibility in offshored location(s)	D	Cost performance
15	Poor productivity in offshored locations	D	Cost performance
16	Customer requirement for product specialization	E	Customer
17	Proximity to market or customers	E	Customer
18	Customer perception of “Made in USA” products and associated service	E	Customer
19	Long lead time from offshored location(s)	E	Customer
20	Political risk (instability) in offshored location(s)	F	Market condition
21	Administrative conditions and cost in offshored locations	F	Market condition
22	Regulatory requirement for products imported to or sold in home country (e.g. FDA)	F	Market condition
23	Government subsidies for relocation	F	Market condition

24	Reponses to volatile demand in home country	G	Response to demand
25	Government and customer pressure to produce goods in home country	G	Response to demand
26	Environmental issues (e.g. natural disaster, environmental sustainability) in offshored location(s)	H	n/a
27	Lack of qualified personnel in offshored location(s)	I	Labor
28	Increasing labor cost in offshored location(s)	I	Labor
29	Labor intensity	I	n/a
30	High communication cost with manufacturing in offshored location(s)	J	n/a
31	Difficulty in control and coordination with manufacturing in offshored location(s)	J	Management
32	Corporate decision to downsize the company	J	n/a
33	Extra management needed for manufacturing and supply chain in offshored location(s)	J	n/a
34	Distance (physical distance and/or perceived difference) with offshored location(s)	J	Management
35	Reorganization of the company	J	Management
36	Potential intellectual property (IP) theft in offshored location(s)	K	Security
37	Security in offshored location	K	Security
38	Being able to automate manufacturing process	L	Automation
39	Technology intensity	L	n/a
40	Poor quality in offshored location(s)	M	Quality
41	High R&D cost associated with products	N	R&D
42	Unavailability of R&D and technology in offshored location(s)	N	R&D
43	Unavailability of technology in offshored location(s)	N	n/a

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